September 3, 1956 50 Cents

AVIATION WEEK

A McGRAW-HILL PUBLICATION

Airlines Outline Helicopter Needs

•

Fairchild Sees Big Potential for Jet

Thompson Trophy Winner

AVIATION CALENDAR

Sept. 3-7—Canadian National Air Show, Toronto, Canada.

Sept. 3-9—Society of British Aircraft Constructors 17th Annual Air Show, Royal Aircraft Establishment, Farnborough, Hampshire, England.

Sept. 5-7—Symposium on Atmospheric Optics, sponsored by Physical Research Labs., Boston Univ., Sargent Camp, Peterborough, N. H.

Sept. 6—Seventh annual Engine Operation & Maintenance Forum, sponsored by Airwork Corp., Pratt & Whitney Aircraft, at Airwork Corp. and Millville Airport, Millville, N. J.

Sept. 8—First annual National Convention of the OX 5 Club, Williamsport, Pa. Contact Clifford Ball, Secy., OX 5 Club, 214 Plaza Bldg., Pittsburgh, Pa.

Sept. 9-11—International Northwest Aviation Council 20th annual convention, Boise, Idaho.

Sept. 10—Pratt & Whitney, Southwest Automotive Co., Engine Forum, Melrose Hotel, Dallas, Tex.

Sept. 10-14—American Society of Mechanical Engineers, Instrument & Regulators Div. Meeting, Detroit, Mich.

Sept. 14-15—Conference on Communications, Roosevelt Hotel, Cedar Rapids, Iowa.

Sept. 17-21—American Society for Testing Materials, Second Pacific National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles, Calif.

Sept. 17—International Air Transport Association 12th annual general meeting, Edinburgh, Scotland.

Sept. 17-21—Eleventh Annual Instrument Automation Conference & Exhibit, sponsored by the Instrument Society of America, Coliseum, New York, N. Y.

Sept. 17-22—International Congress of Astronautics, sponsored by the International Astronautic Federation, Rome, Italy.

Sept. 18-20—Twenty-fourth USAF Aircraft Industry Flying Safety Conference, sponsored by USAF Flight Safety Research, Santa Barbara, Calif.

Sept. 24-26—American Rocket Society, fall meeting, Hotel Statler, Buffalo, N. Y.

Sept. 24-28—1956 Trade Fair of the Atomic Industry, Navy Pier, Chicago, Ill.

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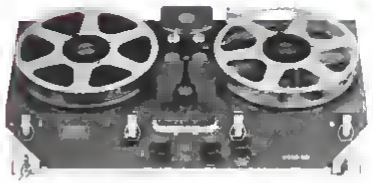

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This installation of an Ampex 800 Airborne Magnetic Recorder in an F-80 at Edwards Airforce Base is at the heart of a major project for developing faster data recording and reduction techniques. Over twenty aircraft companies, government test facilities and others have also purchased Ampex 800s and received delivery in quantity during its first year of production.

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Electronic Armament From General Electric

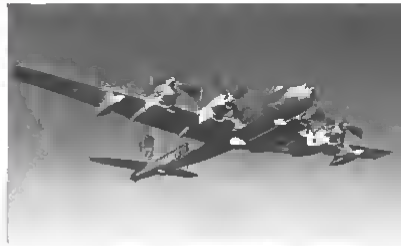
16 YEARS' SYSTEMS ENGINEERING EXPERIENCE BACKS B-47 AND B-52 ARMAMENT PRODUCED BY GENERAL ELECTRIC'S AIRCRAFT PRODUCTS DEPARTMENT

TODAY all Boeing B-47 and most operational B-52 Air Force Bombers are equipped with electronic defense systems designed and developed by General Electric. The evolution of systems engineered bomber defense since 1940 has brought about today's completely integrated armament equipment, remotely operated by a single Air Force gunner.

1940 General Electric entered the bomber armament field with amplidyne turret drives for the Consolidated Aircraft B-24 Liberator.

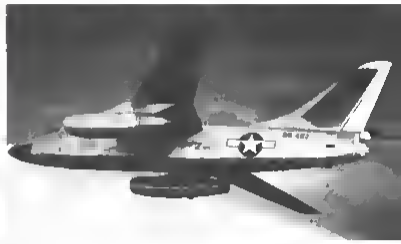
1942 Boeing B-29 Superfortress was defended by the first remote control armament system including General Electric controls and turrets.

1944 G-E control and turrets linked with a periscopic sight allowed Douglas B-26 gunner to aim and fire both upper and lower turrets by remote control.



1945 Standard equipment on the Boeing B-50 included an advanced General Electric, remote controlled armament sighting system.

1949 Convair B-36 is armed with a complete G-E defense system including turrets, sighting stations, radar control and a G-E electronic computer.



1956 The Douglas B-66 was the first tactical bomber to be equipped with radar-directed, automatic tail armament system.

222-4

ENGINEERS: *Expanding electronic bomber defense projects at G-E are creating opportunities for you. Contact C. E. Irwin, Aircraft Products Department, Johnson City, N. Y.*

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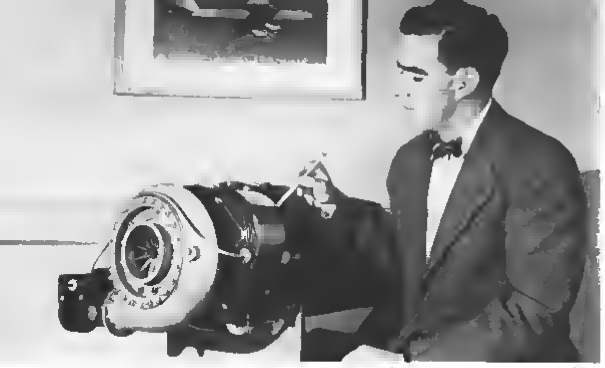
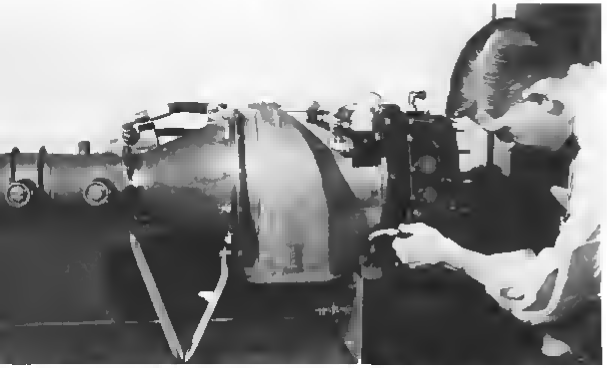


G-E TURBOPUMPS ON THE B-52 are driven by air ducted from the jet engines. These units supply the hydraulic power necessary to operate the bomber's steering, empennage surfaces, landing gear, bomb bay doors, and wing spoilers



G-E TURBODRIVES ON THE B-52 also operate on air ducted from the engines. These constant-speed drives each turn a 60-kva, 400-cps alternator which produces electricity for the B-52's radar, lighting, armament, and control panels.

THE B-52—first aircraft in history to use pneumatic driven power equipment for operating its entire accessory system.

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The Boeing B-52 Stratofortress, newest Air Force jet bomber, uses General Electric turbopumps and turbodrives to help supply its hydraulic and electric power. Chalking up more than 100,000 hours operating time, these weight-saving power packs have helped to make the giant bomber one of the most advanced aircraft in the world today.

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Progress: Vertol is currently developing a flying test bed for the Army under contract with the Office of Naval Research. In this aircraft—a small-scale variant of the larger, more powerful production types to come—a gas turbine drives rotor propellers housed in the wings of the aircraft. To takeoff and land vertically, both wings and rotor propellers pivot straight up, the rotor propellers furnish the necessary lift. At altitude, the wings tilt over into "normal" horizontal position, as the aircraft gathers flying speed, cruise is conventional and fast.

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SEPTEMBER 3, 1956

AVIATION WEEK

VOL. 65 NO. 10

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COVER: Cmdr. Robert W. (Duke) Windsor wears a pleased smile standing in the cockpit of the Chance Vought F8U Crusader in which he made an official speed run of more than 1,000 mph. The run, made at the Naval Ordnance Test Station, China Lake, Calif., won the 1956 Thompson Trophy. Though capable of challenging the British-held speed record of 1,132 mph set by the Fairey Delta FD2, the F8U was held below its top performance on Defense Department orders. The Thompson Trophy was awarded to the Navy at the National Aircraft Show.

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Member ABP and ABC

Scramble for Florida's Coconuts

The question of providing more service linking the lush airlines traffic pools of the Northeast and Midwest with Florida has stirred some interesting controversy. It also has raised a number of problems that are fundamental to the new era of airline operations as a highly-competitive mass transportation business.

Northeast Airlines has come up with the biggest plum to date from the Florida service cases with its recent CAB award of the route to link its New York and New England points with Florida (AW Aug. 20, p. 38). Apparently, one of the major considerations in the Board's 3 to 2 vote for Northeast in the face of a CAB examiner's recommendation favoring Delta was the opportunity to get Northeast off federal subsidy. It is certainly in the public interest to get all airlines off public subsidy as soon as possible. But there also is another issue at stake—providing the public with adequate air service to the rapidly expanding Florida market.

What Can Northeast Provide?

Both Eastern Air Lines and National Airlines, now serving the New York-Miami run, are doing an adequate job. But the growing volume of traffic justifies adding at least another carrier and possibly more. During 1955, the New York-Miami run alone served about 763,000 passengers as compared with about 591,000 on the New York-Chicago run. Yet, there are only two competitors to Miami and five to Chicago from New York.

Just how much additional service Northeast will be able to provide is a question the Board hopes to have answered by 1961. Northeast will face an acute equipment problem, even with the 10 DC-6B transports on order, in the face of the DC-7 fleets of Eastern and National.

Extremely strong cases were presented by other main contenders for the Miami market. Capital was disregarded by the CAB examiner largely because he opined that its Viscounts would not be suitable for the route. Capital has since bought a fleet of Comet IV turbojet transports that would be ideal for this route. Capital still has a chance to break into the Florida market in the Great Lakes-Southeast case where the Comet purchase should strengthen its hand.

Delta, strongly recommended by the CAB examiner, has a DC-7 fleet already operating and has good medium-range jet transports on order. Delta needed only a new 80-mile link to connect its current routes into a New York-Miami route. However, it has benefited greatly from earlier CAB route awards and no doubt suffered because of the Board majority philosophy of trying to transform all the former regional carriers into strong, subsidy-free trunklines.

Pan American's Bid

Perhaps the strongest technical case was presented by Pan American World Airways. It already has established major operating bases in New York and Miami, has a wealth of modern equipment that could be diverted from the North Atlantic summer season to the Miami winter boom, and it has been deadheading a considerable volume of equipment between New York and its over-haul base in Miami. Since U. S. domestic airlines have been put into the international business, there is no longer any logical reason why Pan American should be barred from domestic routes. Just which routes Pan American should be allowed to serve domestically is a moot point. But none fit more logically into its present operating pattern than the New York-Miami link.

In its recent decision in favor of Northeast, the Board appears to be following the trend established by the majority headed by former chairman Ross Rizley of increasing competition, strengthening regional carriers and trying to get all of the major airlines off federal subsidy. These are sound objectives that should serve both the taxpaying and traveling public better, although there will be endless argument over the details the Board chose to achieve these broad goals.

Competition Swells Market

Post-war history has proved that the demand for low-cost air travel has exceeded all forecasts and that increased competitive service, combined with lower fares, swells rather than dilutes the market.

Florida is one of the fastest expanding markets in the country with its pension population and resort boom boosted by solid industrial growth, particularly in engineering and electronics. It deserves a new, expanded air traffic pattern linking it not only to the Northeast but also to the Midwest and Pacific Coast with the fastest and most modern transport equipment available. Not until the Great Lakes Case is decided by the Board and the question of better service to the West Coast is answered, will the proposed Florida traffic pattern be complete. The airline industry and the traveling public are watching with considerable interest the Board's action on Florida service. If the Board's proposals prove to be inadequate, it can expect vociferous reaction from the airlines and communities who are disappointed with its decisions.

—Robert Hotz

WHO'S WHERE

In the Front Office

Frank W. Godsey, Jr., president Air Associates, Inc., Teterboro, N. J., replacing **J. E. Ashman**, now president of Ultrasonic Corp., Cambridge, Mass. Mr. Godsey formerly was general manager, Westinghouse Electric Corp.'s Air Arm, Electronics and Defense Products Divisions.

H. Chapman Rose of Jones, Day, Cockley and Reavis, Cleveland a director, Clevite Corp., Cleveland, Ohio.

H. A. Todd, president of Wisconsin Motor Corp., Milwaukee, and **Robert P. Brooks, Jr.**, vice president of Trundle Consultants, Inc., Cleveland directors, Continental Aviation and Engineering Corp., Detroit, Mich.

Donald S. Smith, president newly formed Hupp International a division of Hupp Corp., Cleveland Ohio.

A. King McCord, president Westinghouse Air Brake Co., Pittsburgh, Pa. Mr. McCord succeeds **E. O. Boshell** who has been serving as board chairman and president, Mr. Boshell remains as board chairman.

W. W. Valentine, president, Sequoia Process Corp., Redwood City, Calif. **Beardsley Graham**, executive vice president, elected a director.

Honors and Elections

David Roller, former airman and now civilian attached to Wright Air Development Center, won the Charles J. Cleary Award for 1955. The award is presented annually to the project engineer who, through original work, makes the outstanding contribution to the WADC Materials Laboratory technical program.

Dr. Richard Filipowsky of Westinghouse Electric Corp.'s electronics division will receive The British Institution of Radio Engineers Heinrich Hertz Premium in recognition of his technical paper, "Electrical Pulse Communication Systems."

Changes

Brooks Honeycutt, assistant director public relations, Allison Division of General Motors Corp., Indianapolis, Ind.

R. M. Rummel, sales-public relations administrative assistant, United Air Lines. **W. M. O'Hern** replaces Mr. Rummel as director of publicity. Also **R. A. Young**, design manager, newly-created Facilities and Property Dept.

John O. McReynolds, manufacturing manager, TelAutograph Corp., Los Angeles, Calif.

Burns R. Mans, aviation sales manager Champion Spark Plug Co., Toledo, Ohio.

Carroll F. Krupp, manager product development Aviation Products Division, B. F. Goodrich Co., Akron, Ohio.

C. E. Heumstadt, plant superintendent Weber Aircraft Corp., Burbank, Calif.

Richard F. Howe, supervisor-experimental manufacturing Research and Advanced Development Division, Avco Manufacturing Corp., Stratford, Conn.

INDUSTRY OBSERVER

► Mocked up test stand at Edwards AFB Rocket Base designed to simulate performance of engine tankage and other components of Convair's Atlas intercontinental ballistic missile is scheduled to begin firings in approximately one week. Other Edwards test stands will simulate the Douglas Thor intermediate-range ballistic missile and North American's Navaho intercontinental missile.

► **Second control facility for the Atlas missile will be constructed for USAF at San Salvador Auxiliary AFB, British West Indies.**

► General Electric has developed experimental avionic components, including tubes, resistors, capacitors, transformers and motors, capable of operating at temperatures up to 500C. Lack of such high temperature components already is being felt in intercontinental ballistic missile and aircraft nuclear propulsion programs.

► **North American F-107 fighter was scheduled to begin its flight test program last week at Edwards AFB. Beginning of program was delayed because of hydraulic troubles. In speed, the aircraft is comparable to Republic's F-105.**

► Martin is developing a new four engine flying boat for anti-submarine and rescue operations. Designation for the Navy aircraft, which will be powered by reciprocating engines, probably will be the P7M.

► **Air Defense Command interceptor versions of the Lockheed F-104A Starfighter will be approximately 200 lb. heavier than the standard day-fighter version scheduled to go to the Tactical Air Command. Under present plans, first F-104As will go to the Defense Command. The aircraft, carrying all-weather gear, will be used on long-range intercept missions.**

► Convair F-102B has been redesignated the F-106A. Primary difference between F-106A and its predecessor F-102A is the change from Pratt & Whitney J57 to Pratt & Whitney J75 powerplant.

► **Vertol Aircraft Corp.'s entry in the Navy utility helicopter competition is the HUP-5, a turbine-powered version of the HUP-2.**

► Bell Rascal missile test program has produced an increasing degree of accuracy and reliability for the rocket-powered air-to-surface missile.

► **Lockheed F-104 flew from Palmdale, Calif., to Albuquerque, N. M., 660 air miles away in one hr., 5 mins. on way to National Aircraft Show in Oklahoma City. Aircraft, piloted by Maj. Stuart Childs, of Edwards AFB, was not pushed.**

► Army is sponsoring a competition for a 400-mph plus turboprop reconnaissance lightplane. Powerplant will be under 1,000 hp.

► **First large-tail versions of Convair's F-102A delta-winged interceptor have been delivered to the 11th Fighter Interceptor Squadron based at Duluth, Minn.**

► Fairchild has launched a new division, tentative called "Operations Research," to investigate new product possibilities brought about by the changing character of military organizations. Central activity at present is with the Army but will eventually extend to all three services. Present emphasis is on lighter equipment for airborne operations. Office of new unit is in Arlington, Va.

► **Major U. S. helicopter manufacturers had total sales of $141,703,000 during the first six months of the year. Military sales accounted for $119,732,000; civilian sales for $21,971,000. The civilian sales increased to $14,079,000 in the second quarter after sales of $7,892,000 in the first quarter.**

Washington Roundup

Democratic Challenge

The Democratic National Committee has unearthed Congressional testimony by top USAF, Navy and Army officers in a campaign year effort to refute Republican Party platform planks defending the administration's defense program over the past three years.

These are the Republican planks and the Democratic comments:

• **Republican**: "We have the strongest striking force in the world . . . which must continue to include (A) a jet-powered, long range Strategic Air Force and a Tactical Air Force with a striking capability superior to any other, (B) the most effective guided and ballistic missiles, and (C) a modern Navy with a powerful naval aircraft arm prepared to keep the sea lanes open to meet any assignment; (D) an Army whose mobility and unit fire power are without equal."

• **Democratic comments**: "(A) Air Force Vice Chief of Staff Gen. Thomas D. White has said that 'in airplane after airplane they (the Communists) are approaching us in quality and surpassing us in quantity' and Air Force Chief of Staff Gen. Nathan Twining told a Senate committee that 'it is in quality that we have been able to stay ahead. However the Soviets are now closing the quality gap.' (B) Russia has already tested an 800 mile guided missile. The maximum range of our Redstone missile is 200 miles; it is reliably reported that Russia will test a 1,500 mile missile by the end of the year; the U.S. has only recently launched a crash program to catch up with the Russians in long-range missile development, but, according to the former Assistant Secretary of the Air Force Trevor Gardner, the program is bogged down in administrative red tape. (C) Vice Adm. Robert P. Briscoe, Deputy Chief of Naval Operations, says the Russian Navy will surpass ours by 1958 unless we embark on an elaborate building program. (D) Gen. Matthew B. Ridgway says that at the time of his resignation as Chief of Staff 'no adequate mobile, ready force was in being.'"

• **Republican**: "We have supported and will continue to support an effective and well directed program of research and development."

• **Democratic comment**: "Lt. Gen. Donald Putt, head of USAF's research and development program, has testified that since 1953, funds needed for USAF research and development programs have been 'inadequate'."

• **Republican**: "In this age of weapons of inconceivable destructiveness we must not neglect the protection of the civilian population by all known means, while at the same time preparing our armed forces for every eventuality."

• **Democratic comment**: "Gen. Earle E. Partridge, head of our Continental Air Defense Command, told a Senate committee in 1956 that if a Russian air attack were launched against us today most of the bombers would get through, stating 'I do not think our defenses are good enough'."

Public Relations Problems

Confidential memo has been circulating among top-level aircraft industry public relations directors suggesting exploration of other methods of handling the Aircraft Industries Assn. public relations program than the current contract with Hill & Knowlton public relations agency.

Memo was authored by one of the top industry public relations experts and has been circulated only among the public relations directors of a few large aircraft firms whose presidents are key figures in the direction of AIA. At the AIA Board of Governors meeting in Williamsburg, Va., last spring, a substantial increase was voted in the Hill & Knowlton budget for the AIA program and several additions have been made to the agency staff in Washington as a result.

Less Manpower for D. C.

Without fanfare, the Defense Department has issued new instructions ordering the military services to cut back on personnel in the Washington area. The policy is to reduce the payroll to the lowest point possible, while still maintaining a capability to do the job.

Secretaries of Army, Navy and Air Force have been ordered to implement the policy, and without resorting to the use of temporary duty or change of definitions to sidestep its intent. Monthly reports must be made to show the number of military and civilian personnel on the job every 30 days.

Pentagon Breather

Pressure of Congressional campaigns will give Pentagon officials a breather before being called before the House Information Subcommittee to continue testimony on public information and secrecy policies and practices. Although the subcommittee considers the Defense Department most important of all government agencies in its inquiry, it has abandoned plans to conclude hearings late this month.

Members want to concentrate on trying to get re-elected. Regardless of whether they're successful, the hearings will be completed sometime between election day and the first of the year. Subcommittee Chairman is Rep. John E. Moss (D-Calif.). Members are Reps. Dante Fascell (D-Fla.) and Clare Hoffman (R-Mich.).

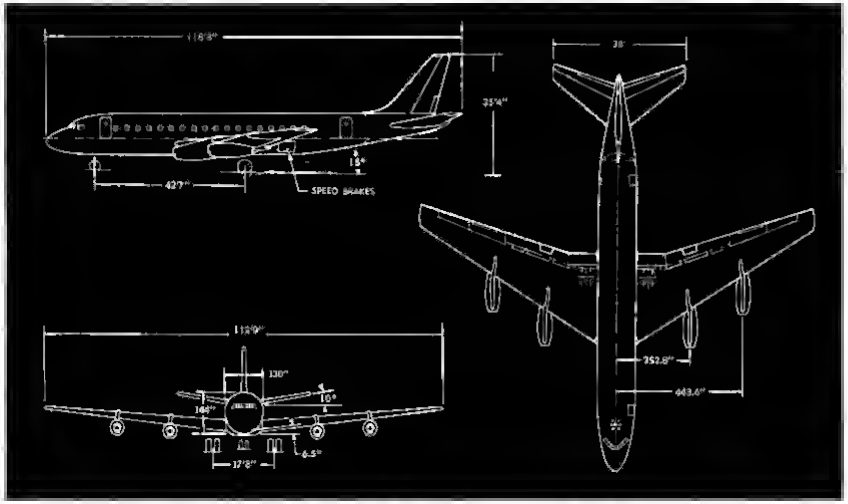
Nike-Talos Evaluation

Now it can be told: Direct result of the 'Revolt of the Colonels' and Pentagon jurisdictional dispute over development and control of anti-aircraft missiles was the appointment of a committee to weigh relative merits of Army's Nike and Navy-USAF Talos. Following Defense Secretary Wilson's "united Pentagon front" press conference (AW May 28 p. 26), Eger V. Murphree, his special assistant for guided missiles, was made chairman of the new group to resolve the interservice controversy. Defense Department says review will be limited to scientific evaluation and not include a duel between the two missiles, as demanded by a Senate committee.

Co-pilot for S-58?

Civil Aeronautics Administration was asked last week to make a co-pilot mandatory in airline operation of Sikorsky's new S-58 helicopter. The request came from Air Line Pilots Assn. President Clarence N. Sayen who told the CAA that say one man operation of the S-58 "would present a potential hazard" because of the complexities of the new helicopter.

The CAA already has certificated the S-58 from an engineering standpoint, but a decision on crew requirements will be included in the operating certificate issued to New York Airways, which plans to start flying the helicopter sometime this month. CAA will decide whether the S-58 needs a co-pilot after studying the NYA route qualification trials. —Washington staff



DOUGLAS DC-9 three-view drawing shows exterior is nearly identical to that of the DC-8. Dimensions are those of DC-8 reduced to roughly .8 scale. Dual wheel main gear differs from the quads used in the larger airplane.

Douglas DC-9 Performance Is Revealed

Top cruising speed is 503 kts. at 30,000 ft., payload is 21,340 lb., and range is 2,425 nautical miles.

Los Angeles—Douglas DC-9 medium range jet transport has reached the point of a final design.

The DC-9 is intended to compete with the Convair 880 (AW June 18, 1956, p. 40). In general dimensions and features it appears to be a replica of the DC-8 drawn to approximately .8 scale. The 880 is somewhat larger, having a maximum gross weight of 173,500 lb. compared to the DC-9's 134,000 lb. maximum.

Convair has no big airplane comparable to the DC-8.

At 85% Power

Top cruising speed of the DC-9 will be 503 kts. at 30,000 ft. with a gross weight of 120,000 lb. using maximum cruise thrust which is 85% of normal rated power. The space limited payload has been set at 21,340 lb. of passengers and cargo.

Range will be 2,425 nautical miles with 37,500 lb. of fuel, take-off gross weight of 134,000 lb. and an average cruising speed of 483 kts. at 35,000 ft. Block speed ranges from 350 kts. for a stage of 300 nautical miles to 445 kts. for 1,000 nautical miles to 460 kts. for 3,000 nautical miles. Design level flight Mach number above 29,300 ft. is 0.68.

Powerplant Choice

Power for the DC-9 will be supplied by four split compressor Pratt & Whitney JT8 turbojet engines, rated at 7,500 lb. thrust each. The engine is a commercial version of the Navy developed J52 and was originally intended as a low specific fuel consumption, small frontal area powerplant for fighters. The Convair 880 will use the 10,000 lb. thrust General Electric J79 turbojet engine.

Total usable fuel capacity of the DC-9 is set at 58,570 lb. For use with the JT8 engine, Douglas has specified JP-4 middle cut gasoline MIL-P-5572, aviation gasoline and Pratt & Whitney's specification PWA 522 kerosene. Pratt & Whitney is now seeking approval from the American Society for Testing Materials (ASTM) for general use of PWA 522.

Landing field length specified for the DC-9 without thrust reversers by CAR 4B is 5,550 ft. on a sea level airport with a landing weight of 105,000 lb. Douglas has made no claim regarding landing field length with reversers. Reverse thrust must be equal to 40% of net forward thrust to meet company requirements.

Each reverser will weigh 100 lb. Noise suppressors will be used which weigh 35 lb. apiece.

As in the DC-8 and the Boeing 707, (AW June 25, 1956, p. 63) two sets of ailerons will be used, one pair inboard and one outboard. The inboard ailerons are very small and give adequate control only at high speeds. The larger outboard ailerons are controlled through a pre-loaded spring linkage. At high speeds, the spring linkage yields to high air load, and as speed increases it progressively washes out the effect of the outboard ailerons while retaining their effectiveness at low speeds. This is to avoid aileron reversal at high subsonic Mach numbers. The Boeing installation differs in that the outboard ailerons are driven by a linkage which is automatically broken when the flaps are retracted.

Wing Flap Spoilers

Like the bigger American jet transports, the DC-9 will have wing flap spoilers in the upper trailing edge of the wing to destroy lift as the airplane touches down in landings. A microswitch interlock in the nosewheel shock strut will prevent the use of the spoilers in the air. They are not intended to provide lateral control as are those of the Boeing 707. Speed brakes are located in the wing root fillets.

Instrument panel on the DC-9 is expected to comply generally with Aeronautical Standard 278 of the Society of Automotive Engineers' S-7 Committee on Cockpit Standardization.

The weather radar used in the DC-9 will probably be an advanced version of RCA's AVQ-10 with a storage tube presentation to provide a trace bright enough to be read easily in daylight without the aid of a hood.

In its present design stage the new airplane has seats for 74 passengers four abreast. As usual, final passenger capacity and accommodations will vary somewhat according to the wishes of buyers. A cabin altitude of 6,700 ft. at an airplane altitude of 40,000 ft. may be maintained by the cabin supercharger turbocompressors, which will be driven by engine compressor bleed air.

New Boeing Transport

Boeing Airplane Co. will soon announce its entry into the small jet transport field with a number of firm orders for a smaller version of the 707.

The aircraft probably will be fitted with the General Electric CJ805 commercial version of the J79, or the Bristol Orpheus. Designed for short runways and with a range of 300 to 2,000 miles, the transport will be designed to have a top speed of over 600 mph.

Orval Cook Considered As New Head for AIA

Washington—Orval Cook, retired USAF general and materiel expert is among the leading candidates being considered by the Aircraft Industries Assn. Board of Governors to replace Dewitt C. Ramsey as AIA president.

Gen. Cook who was deputy USAF chief of staff for materiel, director of procurement for Air Materiel Command and commander of USAF logistics forces in Europe, recently retired with the rank of full general and is now living in Indiana.

Meanwhile, Gen. Joseph McNarney, president of Convair and AIA board chairman, confirmed AVIATION WEEK's exclusive story of August 27 revealing that an active hunt is on for a successor to Ramsey. In a statement prepared and distributed by Avery McBee, public relations director of AIA, Gen. McNarney said:

"The Board of Governors is completely satisfied with the strong leadership which Admiral D. C. Ramsey has given the Aircraft Industries Association during his term of president. Admiral Ramsey has devoted himself vigorously to a tremendous number of critical industry problems and has represented us in a highly capable and efficient manner.

"Admiral Ramsey has indicated that he does not plan to seek extension of his contract beyond its expiration date, July 1, 1958. This is based entirely on personal considerations involving his own health. Under those circumstances, our Board does not consider it is fair to request Admiral Ramsey to continue to carry his heavy burden of responsibility.

"As a consequence, a committee has been appointed by the Board of Governors of the Aircraft Industries Association to screen candidates for his successor. This committee has been active with the full knowledge and cooperation of Admiral Ramsey."

AIA staff sources admitted that whoever was selected for Ramsey's post probably would join the organization before the year's end, presumably as an executive assistant for a period before Ramsey's retirement. However, industry sources discounted the possibility of this procedure, indicating a man of the prestige and caliber being sought would only consider stepping directly into the presidency. Financial provisions would be made to cover the remainder of Ramsey's contract period.

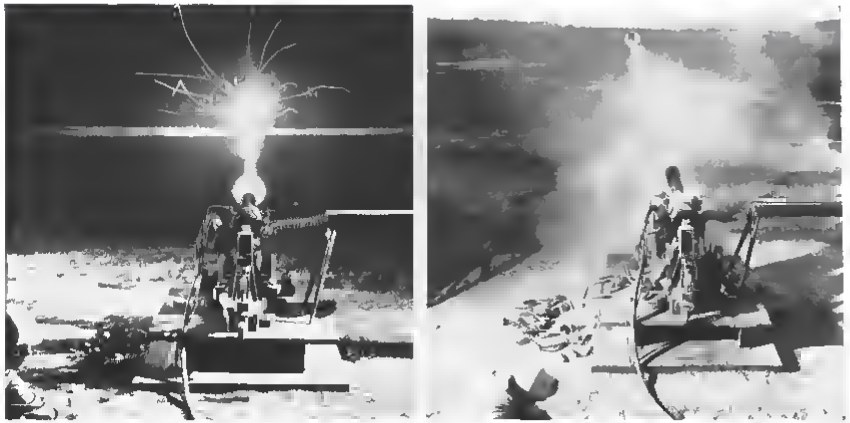
C-130 Demonstrates Climb

Steep climb after takeoff by a Lockheed C-130 Hercules turboprop transport is demonstrated for Maj. Gen. Alvord V. P. Anderson, Jr., commander of the Warner Robins Air Materiel Area, and his staff. The takeoff was made with the airplane loaded almost to its 108,000 lb. design weight. Specifications of the C-130 report a 25-30 deg. angle of climb on takeoff will bring the airplane to 2,500 ft. in 60 sec. (AW July 30, p. 72).

Convair-Astronautics General Contract Let

McNeil Construction Co. of Los Angeles will build the $40 million Convair-Astronautics facility east of San Diego (AW July 23, p. 58). Work will begin at once on the first phase, moving of 200,000 cu. yd. of earth.

Two connected six-story buildings for administration and engineering, a one-story plant building and supporting facilities will be provided for Convair Astronautics, which will develop, manufacture and do preliminary testing of the Atlas ballistic missile and related projects.



SINGLE BELT of electrically primed ammunition feeds all six barrels of General Electric Co.'s 20-mm Vulcan aircraft cannon.

'Gatling Gun' Designed for F-104, F-105

By Evert Clark

Aberdeen Proving Ground, Md.—General Electric Co.'s new six-barrel 20-mm Vulcan aircraft cannon that will arm F-104 and F-105 USAF fighters and B-58 supersonic bombers was officially unveiled here last week. Cyclic rate is around 7,000 rounds per minute.

First picture of the Vulcan appeared in AVIATION WEEK's Aug. 6 issue (p. 307).

Vulcan's high rate of fire and high firepower to weight ratio (50 lb. per barrel) result from application of principles first used 84 years ago in the Gatling machine gun. Fifty caliber machine guns used in World War II planes fired at about 800 rounds per minute.

The Vulcan was developed for USAF by General Electric under Army Ordnance Corps supervision. Air Force designation is T-171. GE is now developing an aiming device for use with the Vulcan.

The six-barrel cluster is rotated counter-clockwise (looking from the breech end) by either external electric or hydraulic drive. Each barrel has its own bolt that holds the shell firmly from entry to ejection, virtually eliminating double feed, according to General Electric.

A single belt of electrically primed ammunition feeds all barrels. Rounds are picked up at the 5 o'clock position, fired at 12 o'clock and ejected at the 7 o'clock position. Indications are that empty shells would be stored inside the aircraft until a mission is ended.

General Electric, the Army and the Air Research and Development Command's Air Force Armament Center at Eglin AFB, Fla., have put four models of the Vulcan through extensive tests. ARDC said that, after more than two years of testing, its project engineers found the Vulcan program "very reliable."

The Vulcan has been flown in an F-94 test aircraft at Eglin and has been tested in the Lockheed F-104.

Although no production contracts have been announced, General Electric said its production capacity will be 25 Vulcans a month by the end of this year.

What Vulcan Will Do

GE and USAF claim these advantages for the gun:

- **Superior dispersion** through barrel stability and reduced vibration. Clamping the six barrels rigidly together eliminates the "whip" of a single barrel, and firing one round at a time eliminates erratic recoil of a multiple gun installation. Centralized recoil also eliminates turret oscillation.
- **Unprecedented reliability** due to external power supply. Each round is independent of the previously fired round, "dud" rounds are ejected automatically and cannot cause stoppages, the gun is inherently cleaner and less susceptible to corrosion than gas-actuated guns. The lower per-barrel rate of fire also means cooler operation.
- **Little maintenance is required.** Vulcan's rotary motion and reduced vibration mean longer life for parts and mounting. The gun can be field stripped for cleaning and maintenance and reassembled in less than 30 min. Complete disassembly and reassembly can be accomplished in less than half a day.

Details on range, muzzle velocity and exact rate of fire are still classified.

Vulcan Weight

Weight is 290-300 lb. and length is 72 in. Model A had 779 parts, the present Model D has only 448. First models, designed for .60-caliber ammunition, weighed 71 lb. per barrel. Later models include several features not on the original model—a rounds counter actuator, booster take-off gun heater, feeder synchronization and gun clearing assembly.

General Electric said the Air Force concluded after low temperature and high-altitude tests that the Vulcan operated as well at temperatures down to and including −67F as it did at room temperature when the gun heater is turned on at the appropriate time prior to firing. The tests also demonstrated that parts not heated prior to firing performed satisfactorily.

Standard lubricants are satisfactory and altitude conditions had no effect on firing or on functioning of the electrical connections, according to GE.

Another feature of the Vulcan is a half rate of fire for strafing.

Sanford Engineering Co. of Oxford, Conn., assisted General Electric in link design and Autowyre Works, Oakville, Conn., assisted with link manufacture.

Development of the T-45, first of the Vulcan series, resulted from the Army Air Corps' realization in World War II that weight and rate of fire would be drastically altered by speeds of supersonic aircraft.

In 1946, General Electric's Aeronautics and Ordnance Systems Division at Schenectady, N. Y., was commissioned to develop an aircraft cannon under supervision of Ordnance Corps' Springfield Armory.

Army and General Electric engineers made a detailed study of every gun mechanism patented in this country and decided that Richard Jordan Gatling's multi-barrel machine gun principle, first patented in 1862, promised the best rate of fire.

The first Gatling was designed for .58-caliber ammunition. Later it was modified for both .50-caliber and 1-in. ammunition.

The 1903 Model Gatling used at the demonstration here for comparison to the Vulcan fired .303 ammunition. The Army did not declare the Gatling obsolete until 1911.

Although the barrel-cluster on the 1903 model was turned by a hand crank, Gatling received a patent in 1893 for an electric motor that was mounted in the rear of the gun casing and drove the gun at the then fantastic rate of 3,000 rounds per minute.

In the F-104, the Vulcan probably will be fired through a gun port on the left side of the fuselage below the cockpit. In the Convair B-58 Hustler, the Vulcan presumably will be used in a flexible mount in the tail.

VULCAN (left) and a 1903 model Gatling gun are demonstrated side by side.

Defense Awards $5,335 Million Aircraft, Missile Contracts in '55

Washington—Aircraft and missile manufacturers were awarded $5,335 million in Defense Department contracts during 1955. The figure, announced last week, was 34.9% of all Pentagon procurement.

Topping the list of firms with military contracts was Boeing Airplane Co., manufacturer of the B-52 intercontinental jet bomber, with orders valued at $797.2 million, or 5.2% of the total.

Close second to Boeing was North American Aviation Inc., with $790.9 million, also calculated to be about 5.2% of the total. Third highest was General Dynamics Corp., which includes Convair. The corporation won $781.7 million in contracts, 5.1% of the total.

In the new list of 100 largest contract winners covering the last calendar year, General Motors Corp. long the top-ranking defense contractor, slipped to 14th place with $182.1 million, only 1.2% of the total awards. However, in a recapitulation for the five-and-a-half year period from July, 1950, to December, 1955, General Motors still ranks as the busiest contractor with 5.2% of all outstanding defense contracts. Boeing ranks second with 4.6%.

In a statement accompanying the lists, the Defense Department pointed out that the 1955 awards represent a more normal period of procurement than the years of the Korean buildup—1950 to 1953—and those of extensive cancellations—1953 to 1954.

The Department said there are factors that tend to increase the percentage of contracts awarded to some of the companies consistently among the top 100 contractors. These are:

- **Acquisition of subsidiaries** that also are prime military contractors. A total of 304 companies, including parent and subsidiary firms, were represented on the list as of December 1955, as compared with 240 as of June 1953.
- **Increasing emphasis** on aircraft and missiles. These products as a rule can be given only to large companies with the capability to act as prime contractor on complex projects.

Fourth-ranking corporation on the list of 1955 contract awards is United Aircraft, $587.4 million.

Others in the first ten are General Electric, $570.2 million; American Telephone and Telegraph, $505.3 million; Ford Motor, $472.2 million; Lockheed Aircraft, $412.7 million; Curtiss-Wright Corp., $354.7, and Douglas Aircraft, $291.1.

AF Transports Snark In Douglas C-124

Hawthorne, Calif.—U.S. Air Force transports its Snark SM-62 intercontinental guided missiles from the Northrop aircraft factory here to launching sites in standard Douglas Globemaster C-124 transports.

Snark can be airlifted in a matter of hours from Hawthorne to potential launching sites near any airfield in the world capable of receiving C-124 aircraft.

One of the Snark missiles arrived in Oklahoma City aboard a C-124 for display at the National Aircraft Show Sept. 1, 2 and 3.

Air Force has been using C-124 transports regularly in delivering Snark missiles to the Air Force Missile Test Center at Patrick Air Force Base, Fla.

Single C-124 transports a complete Snark. The fuselage is rolled aboard on its regular ground handling dolly. Wings and vertical tail fin are removed for stowage aboard the Globemaster.

Missiles are loaded for delivery at Northrop's flight facilities at Los Angeles International Airport. Field assembly of major components is accomplished rapidly once the Snark arrives at the launching site.

Snark, designed to deliver a nuclear warhead over intercontinental distances, is 74 ft. long, 42 ft. in wing span and 15 ft. high. It is now powered by a Pratt & Whitney J57 turbojet engine.

NEW PETREL details released by Navy confirm earlier Aviation Week estimates of 24 ft. length and 13 ft. wingspan (AW April 9, p. 33). Missile gross weight is 3,500 lb. It combines jettisonable airframe and J44 turbojet powerplant with a standard Navy airborne torpedo. Active homing system guides the Petrel to within normal torpedo range where a radio altimeter gives the jettisoning signal. With airframe removed, the torpedo makes a normal drop and run-in to target. Launching is from a Lockheed P2V-6B Neptune capable of carrying two Petrels on underwing pylons. Navy says a number of aircraft are so equipped, and is planning to outfit squadrons for both Atlantic and Pacific fleets.

Curtiss-Wright Orders Water Loop

Garden City, N. Y.—Curtiss-Wright contract to design, build and operate a water loop test facility for nuclear research has been awarded Walter Kidde Nuclear Laboratories, Inc.

A water loop is a piping circuit in which the same fluid is recirculated to carry heat away from a certain point. In this case the laboratories are modifying a 50 ft. loop built four years ago for the Atomic Energy Commission. It is composed of an industrial-type pump and lagged piping from two to ten inches in diameter.

Wilbur E. Kelley, president of the laboratories, explained that water could be pumped around this circuit at fairly high velocities and pressures. A 4-ft. section of 2-in. pipe in one of the vertical legs of the circuit will be removed after check-out, he said, and in its place flow elements which Curtiss-Wright wants tested will be connected. The container for these elements will admit the necessary pressure and temperature taps for instrumentation.

Presumably the object of this loop is to test the cooling system which the laboratories are under contract to design for Curtiss-Wright's nuclear aircraft powerplant. They will investigate the heat transfer and the flutter of the system.

Another contract which Kidde has with Curtiss-Wright covers the design of a liquid metal loop for Curtiss-Wright's Quehanna, Pa., nuclear test facility. This could either be used independently or in conjunction with the swimming pool reactor planned for Quehanna.

The Kidde Laboratories which lack the size to compete with larger firms in major atomic programs, concentrate on handling nuclear problems on a consulting basis.

Besides the Curtiss-Wright water loop, the laboratories are designing a circulating water cooled test reactor for Pratt & Whitney and are studying nuclear power batteries for Elgin National Watch Co. In the nuclear airframe field the laboratories are doing work for Convair and Glenn L. Martin.

Douglas, Lockheed Decline AIA Miami Bid

Washington—Two major U.S. aircraft manufacturers have declined invitations to take part in the Aircraft Industries Assn.'s Latin American Aviation Conference in Miami, Nov. 14-16 (AW June 4, p. 37).

Neither Douglas Aircraft Co. nor Lockheed Aircraft Corp. will attend the meeting to discuss a co-ordinated military and commercial program covering present and future Latin American equipment needs.

Spokesmen for the two companies said their sales staffs have prior commitments and indicated in both cases that they have more important sales interests at this time. Two competitors of Douglas and Lockheed are active in laying plans for the Miami conference. They are Convair and Boeing Airplane Co.

Charles H. Shuff, of Westinghouse Electric International Corp. and chairman of the AIA Export Committee, said Latin American representatives at the session will tell about their problems. U.S. military and civilian aviation leaders will tell what can be provided to meet their needs. The conference will cover present and projected needs and availability of equipment for military and naval aviation.

Requirements for civil aviation products including transports, utility aircraft, helicopters, engines and major accessories also will be discussed.

No list of speakers for the meeting has been announced. The session originally was planned for last February but was postponed on orders from AIA President Dewitt C. Ramsey.

Curtiss-Wright Pilot Killed in F11F Crash

William M. Drake, 34, test pilot for Curtiss-Wright Corp., was killed at Edwards AFB, Calif., last week in the crash of a Grumman F11F.

The plane was undergoing routine afterburner tests when a flameout just prior to landing forced Drake to try and set the aircraft down in the desert short of the landing area. The aircraft is powered by the Wright J65 engine.

FOUR SPERRY SPARROW air-to-air missiles are mounted on missile carrying version of McDonnell Demon, designated F3H-2M, which went into operational service last month. Demon carries 20 mm. cannon as part of armament. The McDonnell all-weather fighter is powered by an Allison J71 engine.

USAF Service Centers Will Be Cut to Five

Three of the seven Flight Service Centers at Air Force bases in the United States will be eliminated and their operations will be taken over by the four other centers and a new one to be selected. The centers, which provide such services as transmitting flight plans and providing in-flight advisory service on request, are being reduced to provide more efficient, consolidated operation.

The March AFB, Calif., Center will close early in October and the Hamilton AFB center will take over its area of responsibility.

Centers at Wright-Patterson AFB, Ohio, and Lowry AFB, Col., will be closed and the new center at a base not yet designated will take over their areas in 12 to 18 months.

Defense Asks Copter Instrument Solution

Helicopter instrument flight is one of six problems thrown out for solution to the nation's inventors by the Department of Defense through the National Inventors Council of the Department of Commerce.

The problems, cited as currently limiting the effective operation of Army helicopters, are:

- **Helicopter instrument flight**, including the instruments, techniques and aids to permit the rotary-wing craft to operate in minimum conditions equivalent to those now flown by fixed-wing planes.
- **Rotor blade stall indicator**, to measure and present a continuous recording of the blade stall on the retreating blade.
- **Coating for skis** or ski-type landing gear to have a low coefficient of friction on dirt and clay, excellent abrasion resistance, good adhesion to wood or metal, and which will not freeze to ice, absorb moisture, rot or deteriorate.
- **Electronic stethescope** for gear components in action, for comparing sounds given off by worn parts such as bearings or gears with the normal sound of new parts.
- **Metal-to-metal bond** inspection technique, for checking structural joints.

Further information can be obtained from the council, Washington 25, D.C.

Propeller Shipments

Plants manufacturing complete aircraft propellers shipped propellers and parts valued at $57.4 million during the first half of 1956 according to the Bureau of Census and the Civil Aeronautics Administration. The shipments represent an 8% decrease over the same period of 1955. Figures listed below under other products and services include experimental and developmental work by companies manufacturing complete aircraft propellers:

Period	Value of All Products Total	For Military	For Civilian	Other Products and Services
	(000 Omitted)			
1956				
1st Quarter	$40,343	$21,520	$6,430	$12,393
2nd Quarter	45,014	21,639	7,837	15,538
1955				
1st Quarter	41,121	26,246	5,269	9,606
2nd Quarter	40,757	25,827	4,964	9,966
3rd Quarter	34,222	21,830	3,601	8,791
4th Quarter	44,431	28,004	4,293	12,134

WHITE phosphorus bomb explodes below Martin B-57 in low level run over ground target still burning from previous strike.

NAPALM drop by a finger formation of Republic F-84Fs envelops a ground target during a firepower demonstration at Eglin AFB.

LAB SYSTEM used by F-100 (left) is technique for bomb tossing during low level dash to target is used with atomic weapons.

Toss Bombing, Napalm, Phosphorus Etch Firepower Patterns

ON THE DECK, a tight formation of eight F-84Fs salvos napalm against target of buildings and old automobiles.

Research Expense for Electra Holds Down Lockheed Earning

Research and development expenditures of $8.7 million, largely for the Electra turboprop transport, reduced net earnings of the Lockheed Aircraft Corp. from $9 million or $3.21 a share for the first half of 1955 to $7.5 million or $2.66 a share this year.

Lockheed's Missiles Systems Division, which is flying two types of research missiles for the Air Force, is near the contract stage with both the USAF and Navy, but the new business potential could not be reflected in the first half report.

Military sales rose from $283,360,000 last year to $283,848,000 in the first half of 1956. Lockheed's military work includes operating a nuclear test center for the Air Force and nuclear airplane design and development contracts.

Lockheed backlog increased to a peacetime high of $1.3 billion. Commercial backlog of orders for 230 airliners also reached a new high of $469 million. Commercial orders received in the first half of 1956 totaled 52 airplanes from 11 airlines. However, first half sales of $51.9 million were down from the record $89.3 million established in the first half last year.

Total sales were $335 million, compared to $372 million last year. Improvement in manufacturing efficiency produced a more favorable cost-to-sales ratio, and strengthened Lockheed's earning position.

United

United Aircraft board of directors have voted stockholders the right to subscribe to shares of new convertible preference stock at ratio of one share of new preference stock for each 16 shares of common stock on record at close of business on Sept. 17 or at such later time as the registration statement covering the new stock becomes effective. Price of new shares, to be determined by board of directors shortly before subscription offer is made, will not be less than the par value of $100 per share.

Solar

Net loss of $189,200 or 27 cents a share was reported by Solar Aircraft Co., for the quarter ending July 31 as a result of a month long strike at its Des Moines, Iowa plant. That the loss was transitory is indicated by new orders of $21 million obtained in the same quarter, bringing the company backlog to $80 million.

Solar directors declared the regular 25-cent quarterly dividend. Solar's sales for the quarter, the first of Solar's fiscal year, were $15.9 million compared with $12.9 million the year before.

When the strike began, the Des Moines plant was engaged in high volume production of jet engine and guided missile assemblies and the San Diego plant was changing over for new programs.

The result was a sharp cutback in anticipated sales and profits.

Solar net was $380,600 or 56 cents a share in the comparable three-month period in 1955.

Fairchild Camera

Fairchild Camera and Instrument Corp. earned $1.72 a share for the first half of 1956, including 42 cents from the sale of its facility at Jamaica, N. Y. Net sales of the Syosset, N. Y. firm totaled $20 million, compared with $16 million for the first half of 1955. New orders rose to $13 million.

General Controls

General Controls Co., Glendale, Calif., net was $614,193, or 69 cents a share, compared with $722,198 or 86 cents a share in the first half of 1955.

The first half 1956 sales were higher—$13.4 million compared with $12.3 million last year.

B. F. Goodrich

Sales and net income were down compared with the first half of 1955 for the B. F. Goodrich Co., Akron, Ohio.

First half 1956 sales were $364 million, net $21 million and earnings per share $2.41. Last year the comparable figures were: sales, $372 million, net $22 million, and income per share, $2.52.

Dividends

Dividends have been declared by the following companies:

- **Lockheed Aircraft Corp.**, 60-cent quarterly dividend payable Sept. 11.
- **Northrop Aircraft Inc.**, 40-cent quarterly dividend payable Aug. 31.
- **Chance Vought Aircraft, Inc.**, 40 cents payable Sept. 24 to stockholders of record Sept. 7.
- **Glenn L. Martin**, quarterly dividend of 40 cents, payable Sept. 26 to stockholders of record Sept. 7.

Royal Australian Navy Grounds Sea Venom

Melbourne—Entire fleet of newly acquired de Havilland Sea Venom aircraft has been grounded by the Royal Australian Navy following preliminary investigations of a fatal crash. Defects in the control system are suspected, and other troubles exist which are likely to reduce Sea Venom efficiency in certain conditions.

Australian Navy's new aircraft carrier Melbourne now has all its new aircraft grounded pending further investigation. Training cruises and all flying activities have been suspended for an indefinite period of time.

Air Show Coverage

Aviation Week readers will get on-the-spot reports from three major air shows in the Sept. 10 issue.

Publisher Robert W. Martin and Editor Robert Hotz will attend the Society of British Aircraft Constructors flying display at Farnborough, England. Managing Editor Alpheus W. Jessup will cover the Canadian National Air Show in Toronto, and an editorial team headed by Military Editor Claude Witze will report on the National Aircraft Show at Oklahoma City.

Other on-the-spot international coverage by the Aviation Week staff in September will come from Rome where David Anderton, assistant managing editor (technical), is a delegate to the International Congress of Astronautics and Edinburgh where the International Air Transport Association will hold its 12th annual general meeting.

News Digest

Royal Canadian Air Force announced increase of flying pay for air crew members from $30 a month to a graduated scale of from $75 to $150 a month. New scale, effective as of July 1, is in addition to regular pay and allowances. Purpose is to aid in recruiting and because of "the increasing complexity of military aviation in recent years."

Boeing KC-135 jet tanker output will increase from a peak of 17 to 20 a month, following USAF recommendation that Defense Department allocate an additional $150 million for the program (AW Aug. 20, p. 29). First of

KC-135s will make maiden flight from Renton, Wash., to Seattle around Sept. 10 for USAF delivery. Flight may come even sooner if tests are completed.

Employment at Douglas Aircraft Co. topped 80,000 new peacetime high. Approximately 68,000 are at work in the three Southern California divisions. Total payroll for five divisions amounts to $400 million a year.

Initial steps for installation of radar at New Zealand airports were announced by Civil Aviation Ministry. Program will cost $2,064,000.

Bell Aircraft Corp. Helicopter Division announced sale of 20 Model 47G helicopters to French Air Ministry. Order is largest of year for division.

Gordon Enterprises, North Hollywood, received contract from USAF for giant camera 25 ft. long, weighing five tons with 30-in. lens. Camera will be used by Flight Test Center at Edwards AFB.

Temco Aviation Corp. will manufacture additional McDonnell F3H Demon wings and aft fuselages. New order is carry-on of Temco's present contract providing for similar components for Navy fighter.

Republic of Indonesia ordered $55 million worth of UF-1 Albatross air-sea rescue amphibians from the Grumman Aircraft Engineering Corp. First delivery will be made in 16 months.

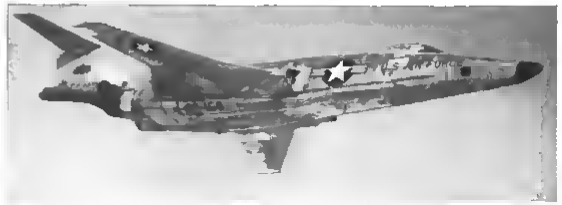
Strategic Air Command's 27th Fighter Wing at Bergstrom AFB will convert from Republic F-84s to McDonnell F-101 Voodoos in October.

CAA Observer Tom Ray is convinced radical changes must be made in rafts and equipment for commercial aviation water rescue after witnessing Coast Guard practice ditching exercise in Biscayne Bay, Fla. Some objections: canopies and spray shields of military type raft could not be adjusted in high wind; Pan American raft lacked radar reflector; survivors could only board PanAm raft at one spot.

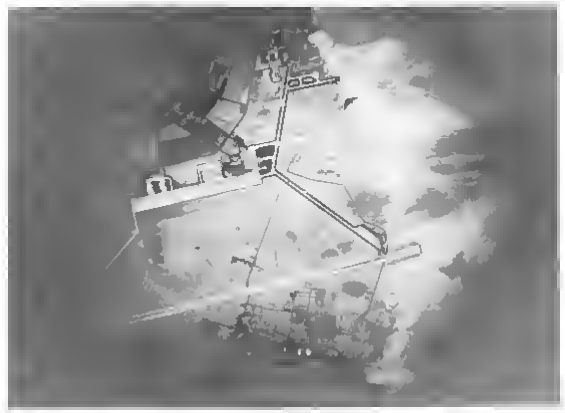
Lear electronic autopilots will be used in all Air France Sneasc Caravelle jet transports. Contract starts with 13 advanced automatic flight control systems, the Lear 17, which uses transistors in place of vacuum tubes.

HUL-1, Bell four-place utility helicopter participated in test trials for Navy aboard carrier Tarawa off coast of Rhode Island. Single rotor helicopter is powered by 260 hp. Lycoming VO-435 engine.

Voodoo Tests Camera Capability



McDONNELL RF-101 used forward oblique camera on California to St. Louis flight. Pictures were made at high subsonic speed, with sighting through ground glass cockpit finder.



EDWARDS AIR FORCE BASE from 30,000 ft. shows runway, road pattern sharply.

GRAND CANYON view covers 2,500 sq. mi. Forest fire smoke is visible at upper right.

Airlines Demand 'Practical' Helicopters

Air Transport Assn. challenges industry to meet promises, provide profitable commercial rotorcraft.

By Claude Witze

Washington—U S helicopter manufacturers are being challenged by the airlines to make good their predictions and produce at least two types of practical commercial aircraft.

In what probably is the first study of its kind that ignores even the existence of military helicopters, the Air Transport Assn.'s Committee on Rotorcraft demands two configurations for passenger service, both with multi-engine reliability.

- **For metropolitan,** or suburban operation—A 20 to 30 passenger helicopter with design payload of 4,400 to 5,300 lb. Routes will be less than 75 miles in most cases, but range of 150 nautical miles must be provided.
- **For inter city or local service** routes—A 35-to-50 passenger helicopter with a design payload of 8,000 to 11,500 lb. Range of 300 nautical miles is essential.

Complete silence by the report on the subject of military helicopters marks the end of a long debate over the possibility that civil requirements can be merged with those of the Army, Navy and Air Force.

No Lease From Military

It also makes it clear that the airlines have abandoned all hope of leasing military helicopters from the Defense Department for operational experience.

This program, advanced more than two years ago by the Army with the support of some manufacturers, has been dropped because of opposition from top Defense Department officials.

At the same time commercial operators have come to feel strongly that the helicopter industry, fat with government contracts, has failed entirely to work on the airline problem.

It has sold a few certificated aircraft to metropolitan operators in Los Angeles, Chicago, New York and Belgium, but all of them are adaptations of military helicopters that fail to meet real commercial standards.

There is no commercial helicopter of the capacity stipulated by the ATA committee. In addition, ATA says commercial helicopters should have such features as:

- **Fuselage width** of about 108 in. inside at window level to accommodate four-abreast seating with an aisle of 18 in., head room of at least 80 in.
- **Cabin windows** 18 in. high and 20 to 30 in. long. Public address system and provision for a cabin attendant, at least one lavatory, two in the inter-city helicopter.
- **Carry-on baggage** provision with 3½ cu. ft. of space for each passenger, plus overhead hat racks and cargo compartments that are easily loaded from outside.
- **Cabin doors at least** 70 in. high and 36 in. wide. Doors should be at the center of the cabin and equipped with integral steps.

Turbine H-16 Planned

No present certificated helicopter provides these comforts. Nearest approach is the Sikorsky S-58, which bears the Army designation of H-34. Outside width of its fuselage is only 68 in. In the 12 passenger commercial version, the seats are in a single line around the cabin.

Only six passengers are convenient to a window.

The Vertol H-21 is not certificated, but the manufacturer has plans to offer a commercial version powered by twin turbine engines. An Army H-21, recently modified to serve as a military executive transport, has only nine seats.

The military services have no helicopter approaching the size of ATA's inter-city aircraft, and there is almost no possibility that they ever will.

The nearest design was the Vertol H-16, a project that has been dropped by the Army. The manufacturer says plans are under way to continue development of the 40 passenger machine with turbine engines using company funds.

Industry Promises

ATA's report confines itself to what kind of hardware is needed by the airlines, what the performance must be and what kind of navigational aids and heliports will be needed. Back of this, however, lies a long history of salesmanship—and promises—by the helicopter manufacturers.

Airline representatives, particularly from the short-haul carriers, make no secret of their disappointment in the performance of the industry.

"There is no question about it," one of them told AVIATION WEEK, "that the industry oversold its product so far as we are concerned."

The spokesman cited speeches and studies by leading rotary-wing proponents and designers going back no farther than 1950. Some of these promised comfortable, certificated, multi-engine helicopters with seats for as many as 52 persons by 1956 or 1957. There was talk of a 40 passenger model capable of 200 mph. speeds.

"Not all manufacturers are guilty," the airline spokesman said, "but some of them are, and it has taken us quite a while to find the truth about the state of the art. Meanwhile, they are selling to the military, despite their (the military's) unhappiness about operating costs."

Actually, ATA itself had much more enthusiasm for the commercial helicopter outlook only three years ago. Basing its conclusions partially on sales talk by leading manufacturers, ATA predicted that 30 to-50 passenger helicopter buses would be competing with surface carriers by 1959 (AW Aug. 21, 1953, p. 13).

Key to the ATA forecast at that time was the fact that prototypes of the Vertol H-16 and Sikorsky S-56, both twin-engine transports, were nearing completion.

Seat-Mile Costs

At the time, their appearance was blamed for part of the coolness shown by short-haul operators towards a fixed wing replacement for the DC-3.

Another study, published near the end of 1953, predicted that a third of all inter-city passengers would fly in helicopters by 1970. It was forecast that there would be six million of them a year by 1960.

The present ATA report declares that a helicopter operated by an airline must attract the low fare, short-haul market and for this reason must have the lowest possible costs per seat or ton-mile.

For the smaller, metropolitan service aircraft, this is understood to mean a figure near 10 cents a seat-mile. In the case of the larger, inter-city helicopter the cost should go down to five or six cents a seat-mile. No present helicopter shows any promise of meeting these figures.

Seat-mile costs for commercial operators are now nearer 50 cents.

Pointing out that the designer should bear in mind that the transport rotorcraft is virtually a "flying bus," the ATA report says cabin appointment must be simple and easily maintained. Passengers must be able to embark and disembark easily from its cabin.

The report also emphasizes safety and declares that systems and components must be designed so that, if they fail, they fail safe.

The ATA committee declared that all-weather reliability is vital for commercial operations and that navigational and landing aids must be developed to make this possible.

Heliport Study

On the subject of heliports the study calls for action based on what is known about helicopter operation.

It sets up criteria as to size, location, zoning, safety, noise problems, obstructions and facilities.

The report admits that some of these standards may have to be changed on the basis of operating experience, but the report says that, unless steps are taken now to provide heliports, undue restrictions lie ahead.

On this subject, ATA and the International Air Transport Assn. disagreed with the manufacturing industry nearly two years ago when the latter discouraged cities and towns from planning heliports.

The Aircraft Industries Assn. Helicopter Council urged at the time that no plans be formalized until more was known about the operating characteristics of commercial helicopters (AW Nov. 29, 1954, p. 13).

No Mention of STOL

The report makes no mention of STOL and VTOL aircraft as a possible replacement for the helicopter despite current military enthusiasm for this type of aircraft.

(One of the reasons given by an Army spokesman for abandonment of the H-16 development project is that the money is needed to press work on other more promising experiments in the STOL field.)

Operating experts from short haul airlines do not deny that the STOL idea holds promise. But, in pressing for more realistic action by helicopter manufacturers to meet their needs, they feel that it will be 1965 or 1970 before STOL or VTOL becomes a commercial possibility.

Earlier Arrival

In recent years the helicopter manufacturers have pledged that practical airline helicopters will be in operation nearly a decade before STOL aircraft can be available.

Airline operators seem to feel that, if the helicopter manufacturers turn to the newer types of transport, the airlines may again be left waiting while military demands are fulfilled.

RUSSIANS are also letting their enthusiasm for commercial helicopter operations outstrip performance. Above is a Russian artist's conception of a commercial helicopter operation linking Vnukovo Airport with downtown Moscow. Sketch shows a civil version of Mil 4 helicopter using Dzherzinsky Square on the edge of the Kremlin as a downtown heliport. Moscow Hotel is large building in background.

Airline Pilots Cut From Ready Reserve

Washington—The Air Force has ordered airline flight personnel in the USAF Reserve removed from units that are on a mobilization basis. The Air Force action, which affects 300 reservists, means that flight crews and other key airline personnel can no longer hold positions in the Air Force Reserve.

The Navy has declined to follow the Air Force lead and will continue to use employes of the air transport industry in its active reserve programs.

Under the new policy, airline pilots, navigators, radio operators, flight engineers, key support personnel and key managerial personnel cannot fill Air National Guard or Air Force Ready Reserve mobilization positions. They are to be reassigned to a reserve program which does not require immediate availability in a national emergency.

In an emergency situation the airlines will be flying military transport missions as part of the Civil Reserve Air Fleet and will provide domestic transportation under the War Air Service Pattern. Aircrews and other key airline personnel will be needed for these mobilization activities and won't be available for active duty as reservists.

In order to be sure that all ready reserve units are composed of personnel available for emergency active duty, the Air Force will transfer airline employes to other programs.

The new policy does not affect the reserve status of the reservists involved. They can continue to earn points for retirement and officers can maintain their eligibility for promotion. Reservists removed from paid mobilization positions can train by correspondence courses or be assigned to an Air Force Reserve Center unit for general training without mobilization assignment.

Air National Guard pilots who were trained under Air Training Command quotas will serve out the tour of duty to which they are committed and will be ordered to active duty in an emergency. Reservists considered essential to the operational training function of Continental Air Command and Air National Guard units will be retained until adequately replaced.

Transatlantic Summer Air Traffic Falls Short of Expectations

By Glenn Garrison

New York—North Atlantic scheduled summer traffic, although up about 12% so far over 1955, is falling considerably short of the 20% or greater increase expected by the airlines at the beginning of the year. Scheduled lines carried about 251,000 passengers during May through July, according to industry sources. Last year's total for the comparable summer period was about 224,000.

Overall load factors on the transatlantic carriers have been somewhat disappointing this year, too. During none of the three months was an average load factor of 90% reached eastbound or westbound. Eastbound, the highest figure was reached in June, with an 89% load factor; the westbound figure for that month was less than 50%.

Passenger Totals

Approximate eastbound passenger totals for the three months were May, 36,000; June, 62,000; July, 51,000. Westbound, the totals were 27,000 for May, 32,000 for June, and 43,000 for July.

On the basis of three months' figures, capacity appears to have outrun the business to some extent. There were some 381,000 seats available in both directions during the period, compared to 309,878 seats during the same period of 1955. Capacity increased about 22% eastbound and about 24% westbound, whereas the traffic increase was 10% eastbound and 15% westbound during the three months.

First class traffic lag has done most to brake the transatlantic traffic rise. The 33,000 first-class passengers who flew the Atlantic eastbound during May through July represented virtually no increase over 1955. At the same time, eastbound first-class seats were up 12% to 45,000. Westbound, first class passengers were up 8% to 27,000 first-class seats up 10% to 44,000.

Tourist traffic fared better. 116,000 eastbound passengers were recorded, a 13% increase. Westbound, the tourist total was 75,000, a rise of 18% over last year.

Tourist seating capacity was up 25% eastbound and 29% westbound during the period.

August Improvement

However, the season isn't over yet, and August figures will show a boost over July's. But first-class traffic may continue to be significantly off.

Trans World Airlines reports a July loss of about 10% from July 1955 in transatlantic first-class traffic, along with an approximate 7% rise in tourist passengers. For August, TWA expects the first-class total to be some 16% less than last year. The airline's tourist traffic for August is expected to be about 18% greater than for the same month in 1955.

Pan American World Airways experienced an 8% first-class traffic increase in July over last year, with a 12% boost in tourist totals. For August, Pan American expects a 6% gain in first-class, a 24% gain in tourist traffic.

PAA Signs Aeroflot Pact

Pan American World Airways became the first American airline to have an exchange agreement with Aeroflot with the signing of an interline pact in Moscow.

Signing of the agreement, which calls for exchange of passengers and cargo between the two carriers is viewed as a possible step towards the introduction of direct service to Moscow by Pan American.

The U S flag airline opened negotiations with the Russian airline at the suggestion of the Soviet government and with the approval of the State Department. Negotiations conducted in Moscow led to the signing of a Pan American-Aeroflot interline pact.

CAA Lists Airways Construction Program

Washington—A partial list of airports to receive more airways and navigation facilities in addition to the 16 areas earmarked for long-range radar (AW Aug. 27, p. 40) has been announced by the Civil Aeronautics Administration.

New facilities being commissioned during fiscal 1957 will represent the first major step towards implementation of the three-year federal airways plan.

The program calls for control towers in 17 locations, high intensity approach lighting in 19 areas and VOR equipment at 82 airports. Airports to receive air traffic control towers are:

Westfield, Mass.; Salem, Ore., Erie, Pa.; Utica, N. Y.; Columbus, Ga.; Longview, Texas; Fargo, N. D.; St. Joseph, Mo.; Santa Fe, N. M.; Fayetteville, N. C.; Stockton, Calif.; Lynchburg, Va.; Worcester, Mass.; Lafayette, La.; Macon, Ga.; Rockford, Ill. and Hobbs, N. M.

Approach Lights

High intensity approach lights will be installed at:

Albany, N. Y.; Charleston, W. Va.; Dayton, Ohio; Newark, N. J.; Austin, Texas; Greensboro, N. C.; Indianapolis, Ind.; Ft. Wayne, Ind.; Billings, Mont.; Louisville, Ky.; Atlanta, Ga.; Birmingham, Ala.; Dallas, Texas; Houston, Texas; Nashville, Tenn.; St. Louis, Mo.; Burbank, Calif., and Spokane, Wash.

New VOR

VOR equipment will established at:

Agricola, Ga.; Akron, Ohio; Altoona, Pa.; Astoria, Oregon; Austin, Nevada; Basolt, Nevada; Beatrice, Nebraska; Bishopville, Md.; Blackwells Corner, Calif.; Burlington, Vt.; Canton, Ohio; Carrollton, Mo.; Cuyahoville, N. Y.; Charlestown, W. Va.; Cincinnati, Ohio; Clarksburg, W. Va.; Cody, Wyo.; Coles Point, Va.; Keene, N. H.; Knobnoster, Mo.; Lakeview, Oregon; Lancaster, Pa.; Liberty, N. Y.; Manchester, N. H.; McCall, Idaho; McCracken, Pa.; Milford, Del.; Miami, Fla.; Minooka, Ill.; Mooresville, Mo.; Newcomerstown, Ohio; Newhall, Calif.; New Madison, Ohio; Northfield, Vermont; O'Neill, Neb.; Oshkosh, Wisc.; Oxcomb, Calif.; Crandall, Texas; Decatur, Ill.; Del Rio, Texas; Detroit City, Mich.; Edenville, N. Y.; El Centro, Calif.; Elk Creek, Wash.; Elgin, Wash.; Ethel, Wash.; Evanston, Illinois; Farallon Islands, Calif.; Fern Prairie, Wash.; Flint, Mich.; Fowlerville, N. Y.; Gilroy, Calif.; Gulfport, Miss.; Hickory Grove, Pa.; Hog Island, Va.; Huntington, W. Va.; Hyannis, Mass.; Jamestown, N. Y.; Jefferson, Missouri; Princeton-Rhicfield, W. Va.; Polvadero, N. M.; Rainelle, W. Va.; Richland Center, Ind.; Richmond, Ind.; Rock Springs, Ariz.; San Bernardino, Calif.; Sandusky, Ohio; Shelbyville, Ind.; Shipman, Illinois; Show Low, Ariz.; Sidney, N. Y.; Sparta Junction, N. J.; Sweetvalley, Pa.; Springville, Pa.; Vesta, Va.; Wilhelm, S. C.; Warm Springs, Nev.; Waterville, N. C.; Wellsville, N. Y.; Westfield, Mass.; Williamsport, Pa., and Zanesville, Ohio.

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Agricola, Ga.; Akron, Ohio; Altoona, Pa.; Astoria, Oregon; Austin, Nevada; Basolt, Nevada; Beatrice, Nebraska; Bishopville, Md.; Blackwells Corner, Calif.; Burlington, Vt.; Canton, Ohio; Carrollton, Mo.; Cuyahoville, N. Y.; Charlestown, W. Va.; Cincinnati, Ohio; Clarksburg, W. Va.; Cody, Wyo.; Coles Point, Va.; Keene, N. H.; Knobnoster, Mo.; Lakeview, Oregon; Lancaster, Pa.; Liberty, N. Y.; Manchester, N. H.; McCall, Idaho; McCracken, Pa.; Milford, Del.; Miami, Fla.; Minooka, Ill.; Mooresville, Mo.; Newcomerstown, Ohio; Newhall, Calif.; New Madison, Ohio; Northfield, Vermont; O'Neill, Neb.; Oshkosh, Wisc.; Oxcomb, Calif.; Crandall, Texas; Decatur, Ill.; Del Rio, Texas; Detroit City, Mich.; Edenville, N. Y.; El Centro, Calif.; Elk Creek, Wash.; Elgin, Wash.; Ethel, Wash.; Evanston, Illinois; Farallon Islands, Calif.; Fern Prairie, Wash.; Flint, Mich.; Fowlerville, N. Y.; Gilroy, Calif.; Gulfport, Miss.; Hickory Grove, Pa.; Hog Island, Va.; Huntington, W. Va.; Hyannis, Mass.; Jamestown, N. Y.; Jefferson, Missouri; Princeton-Rhicfield, W. Va.; Polvadero, N. M.; Rainelle, W. Va.; Richland Center, Ind.; Richmond, Ind.; Rock Springs, Ariz.; San Bernardino, Calif.; Sandusky, Ohio; Shelbyville, Ind.; Shipman, Illinois; Show Low, Ariz.; Sidney, N. Y.; Sparta Junction, N. J.; Sweetvalley, Pa.; Springville, Pa.; Vesta, Va.; Wilhelm, S. C.; Warm Springs, Nev.; Waterville, N. C.; Wellsville, N. Y.; Westfield, Mass.; Williamsport, Pa., and Zanesville, Ohio.

Swissair's First Half Cargo Business Increases

Swissair's cargo operation for the first six months of 1956 totaled 3,349,918 ton miles, an increase of 43% over last year the airline has reported. Biggest gain—66%—occurred on the North Atlantic route. Swissair cargo business was up 25% in Europe, 7% in the Near East, 42% in South America.

The airline plans a second weekly transatlantic all-cargo flight in October.

Tacan/DME Chosen for U.S. Airways

By L. L. Doty

Washington—Tacan compatible DME will be adopted as the common U S air navigation system.

The Tacan controversy, waged between military and civil aviation factions for more than seven years, came to a compromise settlement late last week when the Air Coordinating Committee accepted its Navigation Panel's recommendations.

The Air Coordinating Committee's final decision includes the installation of Tacan stations to replace DME units. Under this arrangement, civil aircraft will be equipped with stripped-down Tacan receivers for distance information. VOR and ILS would remain in use for azimuth data and instrument approach. Military aircraft would be fully equipped with Tacan receivers for all navigational requirements.

The compromise decision is the only practical solution if co-existence of the two systems is to be made technically possible since both Tacan and DME operate in the 1,000 mc band. Tacan has been favored by the military because it offers better security coverage in tactical operations while the Civil Aeronautics Administration has supported DME/VOR as more efficient and accurate.

NBAA Opposition

Even before the decision was formally announced National Business Aircraft Association protested to Louis Rothschild, Undersecretary of Commerce and ACC chairman, that the decision meant "the crucifixion of civil aviation's common system." The Airline Pilots and Owners Association indicated that it also would vigorously oppose the ACC action. The Air Transport Association, an early opponent to Tacan, took a neutral stand in the final stages of the debate, declaring that a final decision has been, and still remains, the essential element of the airline position in this matter."

The Tacan issue has been the cause of much bitterness in aviation circles and a primary reason behind the long delay in the development of a modern airways system. At one time, the battle led to mass resignations in the Navigation Committee of the Research and Development Board.

It has been the target of a number of congressional hearings and, at one time, almost spelled an end to the Air Navigation Development Board.

Navy Instituted Tacan

The Navy began the development of Tacan during the 1948-49 period in a search for a combination rho-theta system capable of providing accurate bearing and distance measuring information for carrier operations, requirements VOR/DME could not fill.

The Air Force joined the Navy in supporting Tacan because the need of a security-bound continental defense system became evident with the explosion of the first atomic bomb by the Russians.

The struggle was long aggravated by the security clamps put on Tacan's development. As a result, the Civil Aeronautics Administration continued its development and implementation of DME/VOR without official knowledge of the Tacan program progress until 1953. By this time CAA had invested $20 million in 450 DME stations.

The veil of secrecy on Tacan was officially lifted in late 1954 when the Navy disclosed some of the details of the system during a Radio Technical Commission for Aeronautics symposium in Washington. AVIATION WEEK had first revealed the Tacan/DME controversy Dec. 7, 1953.

After final declassification of Tacan last year, the controversy continued to flare up as varying solutions to the dilemma were suggested. As late as March 1955, the ANDB cleared the way for the adoption of Tacan as the common system with VOR to serve until 1965 as an interim system. DME service was not to be guaranteed beyond June, 1955.

The CAA refused to bow to the military, however, and continued with its VOR/DME program. ATA, NBAA and AOPA lined up with CAA to bring the struggle to a head this year. During a hearing before the House Government Operations Subcommittee, Rothschild disclosed that the ACC would reach a final decision on the long-debated controversy late this summer.

Meanwhile, the Air Transport Assn. withdrew from its original stand and asked only for a final settlement to the problem to clear the way for a single federal airways system.

Ozark Hi-Per DC-3

Conversion of former Swissair DC-3 for Ozark Airlines includes Hi-Per modifications such as wheel well covers, revised exhaust, in-a-door stair, but uses Pratt & Whitney R-1830-82 engines instead of usual R-2000s. Conversion was done at Pan American Airways Hi-Per modification facility at Brownsville, Tex.

North American Plans Jet Utility Transport

Los Angeles—North American Aviation, Inc., last week announced its decision to enter the race for the large Air Force market in twin-jet utility planes by manufacturing a sweptwing four-passenger-trainer-transport.

North American said it already has completed wind tunnel tests and 25% of the estimated engineering for a transport and combat trainer that will cruise at 45,000-ft. and fly more than half way across the continent without refueling. The aircraft, powered by General Electric J85 turbojet engines, will have a takeoff gross weight of approximately 14,000 lb. Length will be 43 ft. and wingspan 42 ft.

It will carry a crew of two and four passengers. North American said engineering work began early this year after exhaustive preliminary studies. A mock-up will be completed by October and first flight will be early in 1958.

Air Force's Air Materiel Command recently asked 28 manufacturers to consider developing between 1,200 and 1,800 small and medium jet planes for joint commercial-military sales (AW Aug. 27, p. 29).

Cost of prototype development and flight testing of the North American utility plane is estimated at approximately $5 million.

ICAO Pacific Pattern Revised To Permit 'Random' Flight Paths

Washington—A system of "random" flying over the Pacific Ocean that will give pilots a free choice of transocean air tracks has replaced the historic fixed route pattern.

Under a new International Civil Aviation Organization ruling that became effective on Sept. 1, pilots may now plot unrestricted transpacific courses that will enable them to take full advantage of favorable winds and weather conditions.

The system is similar to that governing transatlantic flights.

Previously, transpacific pilots were required to follow one of six established routes between Honolulu and the West Coast. Controlled airways to Wake and Guam were pre-designated tracks 50 mi. wide with a minimum altitude of 2,500 ft. Tracks westward to the Far East were similarly established to conform with routes most commonly flown.

Pilots may now file flight plans over routes of their own choosing without conforming to a pre-established pattern. Courses may be changed en route or flight plans revised only at designated fix points and only after receiving permission from control centers.

All tracks are now set at a width of 140 mi. to allow a 50-mi. leeway and a 20-mi. buffer zone on either side of a central course. A vertical separation of 1,000 ft. is required, and aircraft must hold to a 20 min. longitudinal separation. (The North Atlantic tracks are 120 mi., 1,000 ft. and 30 minutes.)

Navy is insisting upon a minimum altitude of 5,000 ft. for transport aircraft to prevent interference with carrier activity, although it has agreed to give consideration to lower altitude limits in certain areas. Airlines seek lower altitude minimum as one method of avoiding headwinds.

Chief advantage of the random system to the airlines lies in the freedom to select routes that offer the greatest assist from winds and which permit circumventing of poor weather areas.

The old system, based primarily on DC-4 requirements was created in 1948 by the ICAO Northern Pacific Regional Air Navigation Committee at a meeting in Seattle when high altitude flight was not a factor in overseas operations.

However, with the introduction of faster airplanes and pressurized cabins, the airlines felt that an unnecessary operational penalty was imposed by the fixed-route principle. Primarily, the airlines were anxious to take full advantage of the jet stream and other wind currents to maintain maximum operational and economic efficiency.

Furthermore, the airlines decided that jet transport operations will require greater flexibility in traffic flow than would be possible under the old route system. As a result, control of all air space to permit random flying was adopted at a regional air navigation meeting in Manila during November 1955.

All flights will continue to operate under the jurisdiction of Air Route Traffic Control Centers. Centers operated by the Civil Aeronautics Administration are located at Oakland, Seattle, Anchorage, Honolulu and Wake Island.

Centers operated by the military are located at Guam, Midway, Kwajalem, Okinawa and Tokyo.

CAB Postpones Action On Bermuda Fare Hike

Washington—Civil Aeronautics Board has deferred action on international airline agreements involving emigrant fare discounts and Washington-Bermuda fares. Both probably will be eventually disapproved.

The emigrant fare plan was proposed at the Canada meeting of the International Air Transport Assn. The plan would offer a 40% discount from tourist fares to emigrants from Europe.

Pointing out that it had disapproved similar plans in the past, the CAB said it would defer action on the new proposal with a view towards eventual disapproval.

The Board said it appreciates the desirability of facilitating emigrant traffic but feels that this aim may be more adequately accomplished through the use of charter services or other means, which do not involve the discriminatory features here presented."

The IATA agreement involving Washington-Bermuda fares would raise Eastern Air Lines' tourist and first-class fares on the route it absorbed when Eastern took over Colonial Airlines June 1.

Eastern's Colonial Airlines Division flies between Washington and Bermuda via New York. The current fare between Washington and Bermuda is the same as the New York-Bermuda fare. Under the IATA plan, the Washington-Bermuda fare would be increased by the amount of the regular Washington-New York fare.

The CAB said it would not mind a fare increase that reflected the mileage difference on the two routes (Washington is 54 mi. further from Bermuda than is New York). But the Board found the proposed fare exceeds this purpose and would have an impact on domestic fares to the south and west of Washington.

Northwest Awarded New Pittsburgh Routes

Washington—Civil Aeronautics Board has awarded Northwest Airlines authority to operate local service between Pittsburgh-Cleveland and Pittsburgh-Detroit.

With its new authority, the airline can fly a competitive turnaround service in the Pittsburgh-Cleveland and Pittsburgh-Detroit markets now dominated by Capital Airlines.

The CAB also completed an unfinished part of the New York-Chicago case, decided last September, with a decision to allow Eastern Air Lines to continue to operate between Pittsburgh and Akron/Canton, Cleveland and Detroit with a long-haul restriction.

In the New York-Chicago Case, the Board temporarily lifted a closed-door restriction that prohibited Eastern from carrying passengers between Pittsburgh and Akron/Canton, Cleveland or Detroit. Final decision on the restriction issue was deferred for consideration with Northwest's application for turnaround authority.

Northwest was chosen over Eastern to offer new competition for Capital on the route because Northwest is the smaller of the two airlines. The Board said the primary reason for choosing Northwest was that "between Northwest and Eastern, Northwest is much the weaker carrier and is in need of strengthening."

Mohawk Expects Profit From Mail Rate Change

Mohawk Airlines expects its 1955 loss of $65,956 to change into a net profit after renegotiation of a temporary mail rate under which Mohawk operated during the last six months of the year. The local service carrier, in its annual report also predicts a subsidy-free operation by the early 1960s.

Mohawk flew 283,000 passengers a total of 51 million passenger-miles during 1955, the airline reports, for a traffic growth of 28%. Mohawk ranked fourth in passenger traffic among U.S. local service carriers.

Describing the integration of Convair 240s into its DC-3 fleet, Mohawk reports the Convairs were superior in productivity, earning capacity and attractiveness to passengers. Maintenance delays were five to one over the DC-3s during initial operation. Mohawk reports but the ratio leveled out as the maintenance learning curve progressed.

Polish Airline Details Post-War Growth

Warsaw—After ten years of scheduled operation, Polskie Linie Lotnicze (LOT), Communist Poland's state airline, reports that it has increased its passenger traffic four-fold over the pre-World War II level. It hopes to triple present traffic volume within the next five years.

Last year, the airline carried 154,822 passengers on its domestic and international routes, according to International Air Transport Assn. reports. The carrier itself claims an annual load factor of over 79%.

Comparing present traffic with pre-war Polish airline operations, LOT claims that using the 1938 traffic level as a base of 100 ton-kilometers have reached an index of 550 for all services and 1,905 for domestic operations. Passenger traffic is set at 392 overall and 1,760 domestically.

The Polish Government established LOT after World War II with the help of the Russian air force. War-damaged installations were repaired, and the airline began scheduled service in 1946.

The carrier's schedules are tied into the transportation network so that flight arrivals and departures are timed to match railroad and bus schedules.

Flight frequencies reach a high of five to six trips a day on some Polish route segments, and air-taxi service supplements regular airline schedules.

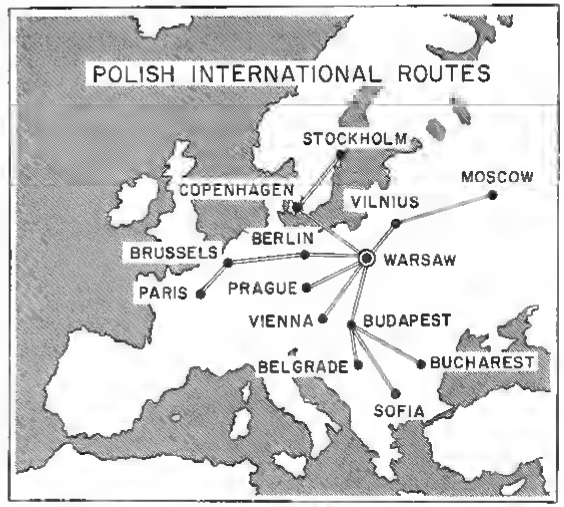
At present, the Polish airline is flying over its route system with a mixed fleet of Li-2, Il-12, Il-14 and C-47 equipment. The carrier also operates dozens of light aircraft.

LOT's domestic route structure is designed to connect Warsaw with the nine provincial centers—Krakow, Wroclaw, Lodz, Poznan, Bydgoszcz, Stettin, Stalinogrud, Gdansk and Rzeszow. The carrier's system also connects the provincial centers and links the southern industrial regions with the northern seaports.

Connections are made at Warsaw with international routes. LOT also flies to Paris, Brussels, Stockholm, Berlin, Copenhagen and Vienna in Western Europe, to Moscow, and to Belgrade, Sofia, Prague, Budapest and Bucharest in Eastern Europe.

Warsaw's Okecie Airport serves as a junction point for operations of such foreign carriers as KLM Royal Dutch Airlines, Aeroflot, German Deutsche Lufthansa, Czechoslovakian Airlines, MALEV Hungarian airlines, CVT Bulgarian airlines and TAROM Rumanian airlines.

Along with its transport operations, LOT operates a fleet of light planes for agricultural, forestry and aerial mapping work.



INTERNATIONAL routes of LOT link Warsaw with European capitals—East and West. Foreign carriers also operate into Warsaw's Okecie Airport. Besides dozens of light aircraft, the airline operates a mixed fleet of Li-2, Il-12, Il-14 and C-47 equipment.

DOMESTIC route structure of Communist Poland's state airline, LOT, connects Warsaw with nine provincial centers and links southern industrial regions with northern seaports. Flight frequencies reach a high of five to six trips a day on some Polish route segments, and schedules are tied into the national transportation network so that flight arrivals and departures are timed to match railroad and bus schedules.

Shortlines

▶**British Overseas Airways Corp.** operated its New York-Bermuda service with a passenger load factor of 97% in May, June and July. BOAC operates two first-class flights a week and a daily tourist service over the route, all with Viscount equipment.

▶**European airlines** will increase flight frequencies by 7% and seat capacity by 12% under new schedules which become effective in October. Capacity will be increased with the introduction of Britannia, DC-7C, Metropolitan, Viscount, Major and S-58 equipment this winter.

▶**International Air Transport Assn.** reports that 9,350,000 passengers traveled over the international routes of the 73 IATA airlines last year. International passenger traffic increased 19% in 1955. While international passengers comprised 18% of the total on all services of IATA airlines, they accounted for 29% of the passenger miles flown in scheduled service in 1955.

▶**Riddle Airlines** has selected Atlanta as a division base for its midwest route. The base will handle eight scheduled flights a day, including a non-stop Atlanta-Chicago service established this month.

▶**Swissair** has three two-week tours of European cities ready for introduction of the IATA excursion fare on Oct. 1. The all-expense tours include trips to London, Amsterdam, The Hague, Brussels and Paris for $586, to Geneva, Madrid, Paris and London for $633, and to Rome, Nice and the French Riviera, Paris and Versailles, London and Windsor for $682.

▶**Trans American Airlines** reports a 13.4% increase in gross revenue for the first half of 1956. Revenues for the first six months were $7,604,410, and the airline flew 120,369 passengers 180,086,000 passenger miles.

▶**Trans World Airlines** will now give ticket stock to firms that are frequent TWA customers. A company travel desk checks reservations by phone, makes out the ticket, and the company reports monthly on the transportation used. TWA has joined a new freight bill clearing plan of the Chase Manhattan Bank.

▶**United Air Lines** will shift its family plan schedule Oct. 1 so it will be effective from Monday noon to Thursday noon instead of the present Tuesday to Thursday schedule.

AIRLINE OBSERVER

▶CAA has raised its employment requirements for traffic controllers from 50 to 300 recruits per month to man the expanded airways facilities scheduled under the three-year federal airways plan.

▶**Air Line Agents Assn., an affiliate of the Air Line Pilots Assn. and representative of some 1,300 office workers and station agents of National Airlines, is suing the company for damages and retroactive pay. The union claims that failure to issue two weeks notice on lay-offs because of a threatened pilots strike was a violation of current contract. Pilots had set August 17 as a strike date, and the airline slowed operations to a virtual standstill in preparation for the strike which the pilots failed to carry out (AW Aug. 27, p. 45).**

▶Aeroflot is flight testing the Tu-104 for scheduled service by replacing Il-12 and Il-14 equipment with the jet transports on certain specified trips. Tu-104 passenger flights have been conducted recently from Moscow to Copenhagen, Bucharest and Peking. For some time, the airplane has operated extensive non-scheduled proving runs over the Moscow-Orient Express route to Khabarovsk in Siberia (AW July 9, p. 26).

▶**Air Transport Assn. has received permission to intervene in the general passenger fare investigation by the Civil Aeronautics Board despite objections of the CAB Bureau Counsel.**

▶Bristol Aircraft urged British Overseas Airways Corp. to operate its Britannia 100s over the North Atlantic route into New York to help boost sales of the turboprop transport. BOAC, however, will schedule the Britannia over Empire routes when the new aircraft goes into service in October. With the Britannia and the Comet IV, BOAC hopes to recover lost ground on its Eastern and African routes from which approximately 65% of the airline's traffic is derived. Boeing Stratocruisers will be kept on the transatlantic route until BOAC receives the longer-range Britannia 300s sometime next year.

▶**Trans-Canada Airlines will begin a pay-later travel plan on Oct. 1 after long resistance to the down-payment system. The credit plan will be available for flights on all TCA routes in North America and Europe.**

▶Four female co-pilots are being recruited by a West Coast supplemental carrier because of the acute shortage of transport pilots. The carrier needs pilots qualified to fly DC-3 and DC-4 equipment to fill crew complements but will require the women to double as stewardesses. While this is the first such request that the Pilots Employment Agency has received, calls previously have been accepted for women pilots to fly executive aircraft.

▶**Chicago Helicopter Airways is the new name of Helicopter Air Service, the airline certificated to operate a scheduled helicopter passenger service in the Chicago area.**

▶Government-owned Trans-Australian Airlines and Australian National Airways have sliced tourist class fares in a rate war being waged against the low-fare, private-owned Ansett Airways, which operates Convair 340 aircraft, and Butler Air Transport operating Vickers Viscounts. Ansett will shortly introduce Convair Metropolitan 440s into service.

▶**Northwest Airlines will redesign the interior of their aircraft next year when delivery of 14 DC-7Cs and eight DC-6Bs is accepted. New interiors, suggested by Douglas Aircraft designers, will emphasize newly-styled carpeting, seat fabrics and curtains. Walnut coloring in varying shades will prevail on walls and bulkheads. Exterior design will undergo only slight modification.**

▶Beirut Airport has opened a tax-free market with 24 separate stores to accommodate over 250,000 transient passengers annually.

IN THE MEDITERRANEAN SEA—Participating in amphibious exercises of the U. S. Navy in the Mediterranean area are Sikorsky HRS helicopters of the Marine Corps. They are shown above with the escort carrier *Siboney*, which carried 15 helicopters from their home base at New River, North Carolina. The training exercises featured helicopter vertical envelopment tactics.

AROUND THE WORLD WITH SIKORSKY HELICOPTERS

SAVED—A DANISH SEAMAN—A Sikorsky HO4S helicopter from the U. S. Coast Guard Station at Salem, Mass., takes a Danish sailor from the merchant ship *Paula Dan* 25 miles off Block Island. The sailor, stricken with acute appendicitis, was lifted in the basket visible below the helicopter and was flown to a hospital ashore for surgery.

SAVED—A U. S. COASTGUARDSMAN—Two days later the same HO4S helicopter picked up a U. S. Coastguardsman from the Nantucket Lightship. Also a victim of acute appendicitis, the man was quickly and safely taken to the same shore hospital. Helicopters have rescued more than 10,000 people in all parts of the world.

LARGER S-58s FOR NEW YORK AIRWAYS—The first of a new fleet of 12 passenger Sikorsky S-58s has been delivered to New York Airways, the helicopter airline serving Greater New York and nearby communities in three states. Sabena Belgian World Airlines has ordered eight for its European helicopter service. Both lines currently use Sikorsky S-55s. The S-58s will be the largest helicopters to be in regular airline service anywhere in the world.

HELICOPTER HISTORY

FIRST SCHEDULED HELICOPTER SERVICE

On October 1, 1947, the world's first scheduled helicopter service was started by Los Angeles Airways, carrying air mail. One of the line's original Sikorsky S-51s, above, is still operating and has flown 10,000 hours. Los Angeles Airways was a pioneer in night operation and instrument flying, and carried over 10 million pounds of air mail in its first three years. The line now carries passengers as well as mail and express in its fleet of Sikorsky S-55s.

Scientists Tackle Jet Noise Problem

By George L. Christian

Cambridge, Mass.—There are three basic ways to calm the noise poured forth by a large jet engine: use a quieter engine, install a muffler, or persuade the public to accept the noise, according to the acoustical consulting firm of Bolt Beranek & Newman, Inc., who are devoting considerable time and energy to the matter. The imminence of commercial jet flight is lending urgency to the problem.

In their studies concerning the specific problem of how to quiet a jet engine, BBN scientists have reached this opinion, "Considering current engine design and the method of mounting powerplants in pods slung under the wing, there is now no apparent, reasonable way of quieting a jet engine." By reasonable, they mean without appreciable thrust loss.

Noise is the noise problem posed by jet aircraft restricted to quieting the engines. At altitudes of 30,000 ft., at jet cruising speeds, boundary layer noise in the airplane begins to exceed that of the turbojets themselves, a situation which may call for a weight penalty in soundproofing.

Sound Specialists

BBN is composed of a group of specialists in all phases of sound attenuation and control. They have tackled and solved such diversified problems as silencing the supersonic NACA wind tunnel at Cleveland, designing a huge anechoic (non-echoing) room for General Electric, and doing the acoustical engineering for the auditoriums conference rooms and broadcasting studios for the United Nations building.

Ideally, a jet's tail pipe should end in a long thin slit instead of a round hole, says BBN. But a long, thin slit will inevitably produce back pressure and decrease thrust, so the problem remains a knotty one.

Substantiating BBN's opinion that large jet engine noise suppression will be difficult is a statement made by E. E. Callaghan of the National Advisory Committee for Aeronautics, Cleveland, at the Second International Congress on Acoustics recently held at the Massachusetts Institute of Technology. Callaghan reported on research he had done with N. D. Sanders on full-scale jet engines.

"Greatly Alleviate"

"I think that it is becoming increasingly evident that we are going to greatly alleviate the noise problem caused by jet engines," Callaghan said. "There may well be some cost in performance and increased mechanical complication and weight. As yet, it would not appear that we have reached our goal of a minimum of 15 decibels reduction of the maximum sound pressure level.

"Continued effort, however, should make such reductions feasible. The conversion of our crude test devices to finished hardware represents considerable development effort. Furthermore, a great many problems of a practical nature remain to be answered."

At the same meeting, Alan Powell, of the Department of Aeronautical Engineering of the University of Southhampton, England, cautioned that, although this first group of commercial jet aircraft, going into service in 1959 and 1960 may not exceed the noise made by present propeller-driven planes, he did not see that the noise suppression techniques now under consideration would reduce noise sufficiently as plane engines got bigger, more powerful and more numerous. He emphasized the need for more research and the need for a more thorough theoretical understanding of this problem.

20 Decibels Too Noisy

Ground noise made by a four-jet transport at takeoff is 15-20 db. above the accepted tolerance level, according to BBN.

Dr. Leo Beranek, president, said that, because neighborhood tolerance to jet noise varies with its intensity, frequency and duration, it is hard to establish an accurate yardstick of what will and what will not be acceptable. He said:

"It was estimated by Boeing in the corrected version of their paper given this year to the Institute of Aeronautical Sciences that the 707, with four engines at takeoff power, will produce a maximum overall sound pressure level of 130 db at 900 ft. (Beranek added parenthetically that independent studies made by his company of the Pratt & Whitney Aircraft J57 substantiate this figure.)

"Assuming an active airport and present-day neighborhood tolerance to airport noise, this level is about 20 decibels greater than currently permissible."

Noise made by the DC-6 series airplane appears to have been accepted by the airlines as the yardstick against which the jets—707, DC-8 and Golden Arrow—will be measured and which they will not be allowed to exceed. In a recent survey made by the Swedish Civil Air Board (AW June 18, p. 107) of the noise level of several different makes of aircraft taking off from Bromma Airport, DC-6Bs' range was 100-116 db., which supports Beranek's statement.

BBN officials cited these three methods of making jet noise more acceptable to those groundlings who have to listen to them:

• **Use a less noisy engine.** Such powerplants as by-pass and low temperature jets are inherently less noisy than the more conventional designs. The by-pass engine, such as the Rolls-Royce Conway, is less noisy because the existing by-pass air reduces the velocity gradient across the exhaust shear plane, quieting the engine. All the noise created by a jet engine at full thrust is caused by the shear along the surface between the rushing exhaust and quiescent ambient air.

By designing a jet which would have a lower total turbine inlet temperature, noise can also be reduced because exit velocity decreases and tail pipe perimeter increases, both being factors which help quiet the engine. Both types of engines will give a noise reduction of approximately 6 db. with no loss in thrust or performance.

• **Use a noise suppressor.** Depending on the design, tail pipe noise suppressors may be expected to cut jet engine noise by about 6 to 18 db. Disadvantages of noise suppressors are that they will impose a certain weight penalty and will create thrust losses ranging from 1 to 5%, both being undesirable to the airlines. Another factor not to be ignored is that no jet exhaust muffler capable of flying yet exists.

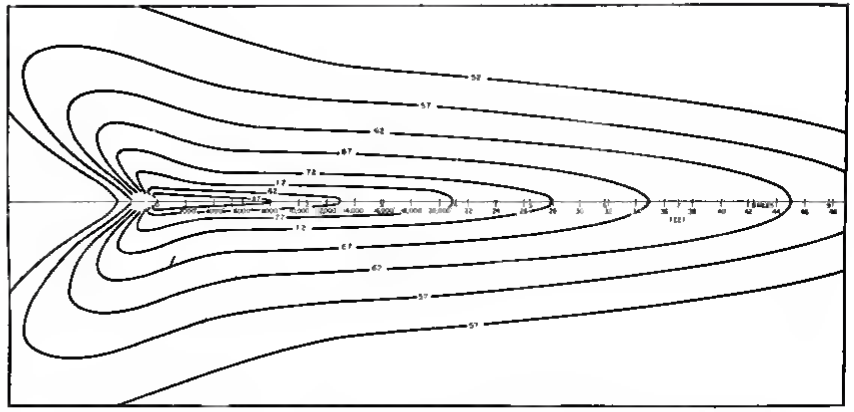
• **Influence the public.** An abstract, psychological factor, but one which may be as effective as the engine type or hardware noise reducers just listed, is an effective public relations campaign which will increase neighborhood tolerance of airport noise 10%.

An unknown factor is whether the different tonal character of jet engine noise compared with piston-engine-plus-propeller will result in a different neighborhood tolerance.

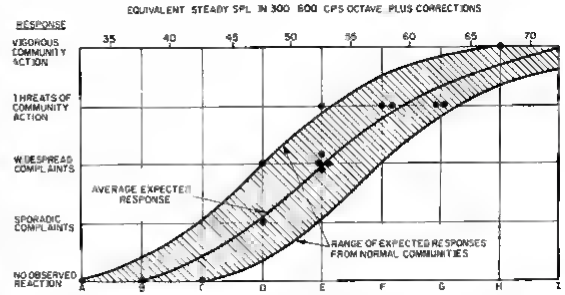
A trend which may mitigate the increased noise of jets is the increasing use of air conditioning, which results in houses being closed both summer and winter. Closed windows and doors do much to reduce noise. This is even more applicable to office and other buildings surrounding the airport.

A noise problem peculiar to jet transports is the fact that, in general

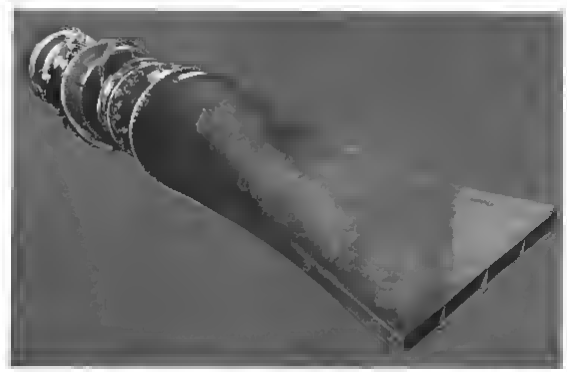
NOISE POWER	NOISE SOURCE
Million Watts	Future Jet Aircraft "Century Series" Jet Fighters Commercial Jet Liners Super-Constellation (Take-Off)
Thousand Watts	DC-3 (Take-Off) Large Pneumatic Riveter Large Orchestra
One Watt	10 HP Outboard Motor Blaring Radio Automobile on Highway
One Thousandth of a Watt	Voice—Shouting
One Millionth of a Watt	Voice—Conversational Level
One Billionth of a Watt	Voice—Very Soft Whisper



CONTOUR plot of jet engine noise is plotted along a scale marked both in miles and feet. Sound levels are in decibels.



AVERAGE expected community response to intruding noise as a function of noise ratings.



HOW an artist conceives a slit exhaust for a turbojet engine, the most effective silencer.

TOOTHED NOZZLE on one of the Pratt & Whitney JT3 L turbojets powering the Boeing 707 is one of several configurations developed by Boeing engineers to quiet the ground noise level of the four podded powerplants. This demonstration, conducted at a mock up air terminal built at Boeing Field, was held for the benefit of 50 airline and six Civil Aeronautics Administration representatives. The 707 was started, taxied out, returned to the ramp and parked repeatedly during a three-hour period to simulate operation in today's air traffic. A Boeing KC-97 added traffic load to the simulated ramp and the normal complement of passenger and baggage handling gear was around. Temperature and velocity of the jet exhaust against the building walls were measured.

terms, the "swish" of the boundary layer exceeds the 'roar" of the engines at altitudes exceeding 30,000 ft. and at sound frequencies above 600 cps. (Important speech range is about 300-5,000 cps.) At 40,000 ft., engine noise boundary layer noise will predominate completely.

Beranek cited these reasons for jet engines becoming quieter at cruise altitude:

- Less air (the air being rarer) is pumped through the engine, therefore less noise is generated in the shear plane.
- Lower velocity gradient exists across the shear plane since the forward motion of the aircraft reduces the relative speeds of exhaust and ambient air by an amount equal to the speed of the aircraft.
- It is harder to generate noise in rarefied air because the air "slides by more easily when rarefied.

Conversely, at low altitude and high engine thrust, the powerplant's roar will be the disquieting noise, particularly in the rear of the plane during take off and climb. BBN officials believe that it will take about twice as much sound-proofing (in terms of weight) to quiet the roar of a commercial jet's cabin than is required in a piston engine plane. However the same men emphasize they see no unsolvable problem to quieting the interior of jets—the real problem lies outside.

Since, at takeoff power, 100% of all noise produced by a jet engine is generated behind the engine, all muffling schemes are concerned with this noise and any sound created within the engine itself is discounted.

The noise is caused by air turbulence occurring at the shear surface between the exhaust air blasting through the still surrounding air. Highest frequencies occur at the engine exhaust where the turbulence shear line between exhaust and ambient air is relatively narrow. Width of the shear line increases as it recedes from the engine tail pipe and the frequency becomes correspondingly lower.

Noise power produced in the exhaust

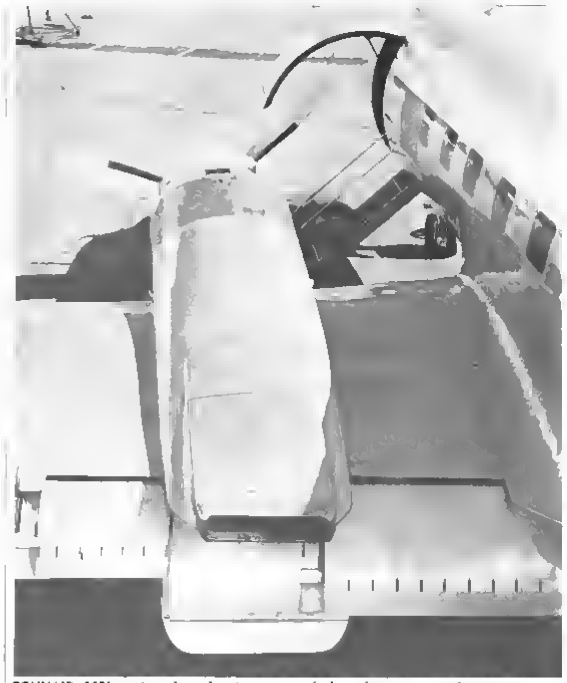
of a jet engine fitted with conventional, circular tail pipe increases with the 8th power of the exit velocity of the exhaust gas. Therefore, any slight increase in the tail pipe's perimeter, transverse to the axis of the engine, will result in an appreciable reduction in noise because of the lowered velocity gradient between exhaust and ambient air. Ideal way to increase the tail pipe's perimeter is to flatten it into a long thin orifice—a "slit exhaust" generally similar in shape to the rectangular trailing edge exhaust the firm developed for the very quiet Convair 440 Metropolitan. As Beranek put it, "We believe that an improved jet engine from the noise standpoint would result if the exhaust . . . could be made in the form of a long, thin slit. Where this slit could go on an airframe, and meet all the other requirements of the airframe and powerplant design is really beyond our province. . . ."

The slit shape is more effective than the flower configuration proposed by Boeing to the IAS earlier this year (AW Jan. 30, p. 28), according to Beranek, because the noise coming out of the flower type silencer tends to regroup, thus partially nullifying the effect of the device.

BBN acoustic experts have done so much work to quiet wind tunnels they have reduced the difficult science to an almost routine job. As they put it, "We have gotten to the point where we can calculate the amount of noise you can expect out of a given wind tunnel."

A major accomplishment in this field was the noise control work the firm did for the world's largest supersonic wind tunnel, the 6 x 8 ft. tunnel operated by the NACA at Lewis Flight Propulsion Laboratory in Cleveland. When the tunnel was first opened, its electrical power requirements were so great that it could only be operated late at night, while Cleveland residents slept.

With the original sound-proofing,



CONVAIR 440's rectangular exhaust opening which replaces two circular jet augmenter tubes is new sound improvement program. New muffler, inner cabin window assemblies in first eight rows of seats, application of acoustical tape to some interior surfaces, addition of fiberglass soundproofing are all part of sound lessening program for 440.

the growl of a ram jet could be heard 10 miles away. Neighborhood reaction was quick and angry. After BBN's additional noise control structure was added, a man walking past the tunnel's exit could tell whether or not it was operating only by feeling the exhausting hot air; all noise has been muffled.

Currently, wind tunnel projects are under way for these companies: two for Douglas, and one each for Convair, North American, Boeing, and Arnold Engineering Development Center.

In the same vein, BBN has designed over 200 jet test units for dozens of engine and airframe manufacturers and for the USAF.

Another important facet of BBN's work is in determining the effects of aircraft noise on airport planning and on the surrounding community.

The firm has been advising the Port of New York Authority for several years on this problem. It still is making many surveys for the military for such purposes as location of new housing near an air base.

The main criterion of noise acceptability is SIL (speech interference level). If noise consistently interferes with speech, the public gets angry. The higher the frequency of interference, the more violently the public reacts.

Another big objection to noise (exclusive of a fear connotation such as might have been generated at Newark where residents had reason to associate aircraft noise with crashes and loss of life) is disturbance of sleep.

Aside from the multi-million dollar anechoic room for GE, which measures 59x49x44 ft. and has walls 18 in. thick, BBN has done these non-aviation jobs: served as acoustics and noise control consultants for General Motors new $100 million Technical center, quieted the latest Lamude and Johnson outboard motors; provided noise elimination and control recommendations for the experimental lightweight Talgo "X" train, undertaken noise control studies on pre-fabricated houses for U. S. Steel Corp., designed Diesel locomotive horns to sound like steam whistles (actual steam whistles required too large a volume of air to be effective).

The company also has done interior acoustical design for such halls as the Kresge Auditorium at M.I.T., the World Zionist Congress Building in Jerusalem and the Aula Magna Auditorium of the University of Venezuela in Caracas.

BBN was formed by R. H. Bolt and L. Beranek in 1948. Both men, plus R. B. Newman and another member of the firm, J. J. Baruch, are on the faculty of M.I.T. besides managing BBN.

The firm grosses $500,000 a year, strictly in acoustical consulting; it produces no hardware.

Soviet Aircraft Training Well Integrated, But Party Plays Heavy Role

By Leon Trilling*

The vertical integration of all facilities and functions—including the training of specialists under the various industrial ministries is especially thorough in the Soviet aircraft industry. Aside from the historical and political factors which have led to the development of vertically integrated industrial complexes under each ministry, the requirements of military security have made it desirable that all research, planning and production within the aircraft industry of the Soviet Union be concentrated under a single leadership and known to as restricted a group as possible.

The Soviet aeronautical industry is embraced in a closely knit complex of three ministries, the Air Force (an air branch of the Ministry of Defense) and the Civil Aviation Ministry as the only customers, and the Ministry of Aircraft Production as the only producer. The training of aeronautical engineers, the administration of aeronautical research laboratories, and the publication of aeronautical technical literature are wholly in the hands of these ministries.

The Air Force and Civil Aviation Ministries specify the performance requirements of any given aircraft, the Air Force playing by far the leading role in this respect, not only because it orders almost the totality of the production but also because regulations require that air transports and passenger aircraft be adaptable to military use with a minimum of effort. The Air Force, therefore, needs and trains a rather large corps of military air engineers particularly skilled in development work, in general design and performance evaluation, and in actual prototype testing. It also trains air engineering officers skilled in the techniques of aircraft repair and maintenance.

This training takes place at three military air academies: the Zhukovsky Military Air Academy in Moscow, the Air Engineering Academy in Leningrad, and the Military Air Engineering College in Riga. The Zhukovsky Academy, founded in 1923 in response to the suggestions of the great Russian aeronautical scientist, N. E. Zhukovsky (1847-1921), and the most important of the three, is very active in research and development on aircraft and other weapons, and trains highly skilled engineers. The Leningrad Academy concentrates on aircraft designers and also maintains a high standard. The Riga Air College specializes in maintenance problems.

On the graduates of the Zhukovsky and Leningrad Air Academies rests the responsibility of deciding what type of aircraft can or should be produced and whether a given prototype fills the bill of particulars. Since their technical competence and judgment determine the quality of the equipment of the Red Air Force, these men are selected and trained with exceptional care.

MIG-17 AND BADGER formations are used as the backdrops for these pictures of Russian pilots in their press. MIG-17 squadron (top) has tail flash in red extending forward along the fuselage to nose. Seven Badger medium jet bombers show first closeup of rear gunner position, with visual observation panels below a small radome. Blister on airplane behind head of fourth pilot from right is unidentified, could be a housing for drogue chutes.

Elite Institution

The Zhukovsky Air Academy is an elite institution to which every year some 1,600 unusually able and reliable young engineering students or engineers are assigned by the Communist party. It is not possible to apply or compete for entrance to the Academy, admission is by party invitation only. Upon admission the young men receive a commission in the Red Air Force Engineering Corps which apparently varies between the rank of lieutenant and captain, depending on previous experience and record. Since they draw military pay and are entitled to uniforms, room, and board at government expense in addition to the equivalent of PX privileges, their material situation is far better than that of a civilian undergraduate or even graduate student.

The course at the Academy, which lasts five years, is almost entirely on a highly advanced level; the students having already completed or nearly completed their regular course before admission. The teaching is by leading scientists some of whom are members of the Academy of Sciences and many of whom hold simultaneous senior professorships at Moscow University or at the Ordzhonikidze Moscow Aeronautical Institute.

Pay scale is higher by 40% at the Zhukovsky Academy than in civilian institutions, except for senior professors, for whom this may be less important in view of their many other sources of income. Until his death last year, V. V. Golubev, head of the Mathematics-Mechanics Faculty of Moscow University, held the Mathematics Chair; the Chair of Aerodynamics has been held for many years by Professor B. N. Yuriev, student of Zhukovsky and senior Soviet applied aerodynamicist.

Not Easily Evaluated

Since military security forbids extensive publication on aeronautical engineering subjects, the creative achievements of the Zhukovsky Academy staff are not easily evaluated, but some idea of their qualifications may be gained by a study of the textbooks which they have published. Approximately one-third of the Soviet aeronautical textbooks available at the Library of Congress have been written by members of the staff of the Zhukovsky Air Academy, notable among them B. N. Yuriev's three-volume *Applied Aerodynamics*, which is a standard required textbook in all Soviet aeronautical institutes.

Other Zhukovsky Academy staff members who have written extensive textbooks include B. N. Goroshchenko (performance of high speed aircraft), Gudtsev (metallurgy), and A. A. Umanski (airplane design).

The Air Academy consists of four principal technical departments or faculties namely, in order of importance and of prestige among the students:

- Aeronautical Engineering Design and Performance
- Aircraft Equipment (in particular, electric, electronic and hydraulic)
- Armament
- Administration

The Faculty of Aeronautical Engineering, which teaches aircraft designing and design evaluation, is primarily concerned with applied aerodynamics—the study of air loads and their effect on the stability and control of an aircraft, the performance, speed range and rate of climb of the aircraft when powered by a specified engine. It also deals with problems of general design, layout and with calculations of strength and rigidity requirements.

The Faculty of Aircraft Equipment teaches the arrangement and design of mechanical, electrical, and hydraulic control systems, landing gears, servomechanisms, and, increasingly in the last few years, considers problems of electronics and guidance.

The Armament Faculty deals with design and installation of conventional aircraft armament.

The Faculty of Administration trains the students in managerial skills and gives them the information they need on the organizations which they will be called upon to serve and to direct.

There is also, of course, the inevitable political department, which, in view of the prominent positions graduates of the Academy are likely to assume, is more extensive than in the average institution of higher learning. Not only does it teach compulsory courses in Marxism-Leninism, the history of the Communist party, political economy, and dialectical materialism, it also sponsors many "voluntary" seminars and discussion sessions on current events, and it closely supervises even leisure time and personal life of the students.

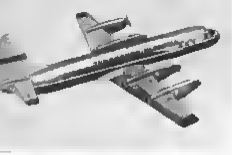
On entering the school, the students (or "cadets," as they are called while at the Academy) are divided into groups of twenty to twenty-five who attend recitations and do laboratory exercises together. The entire student body attends formal lectures together in the first two years. The first year they receive training in the basic sciences (mathematics, physics, etc.), which are treated as service courses not deserving a department of their own. From the middle of the second year on specialization starts with much emphasis on individual work often related to practical weapon development programs.

Some Teach

Although the graduates of the air academies are engineering officers, they do not all pursue military careers. Some become teachers: Melnikov is a professor in Leningrad, Pogorelov is a docent at the Kharkov Aeronautical Institute, Zaks is a docent at the Central Asian Polytechnic Institute in Tashkent, where, since there is no aeronautical faculty or aeronautical institute in Tashkent or anywhere nearby, he is presumably in the Mechanical Engineering Faculty, thus demonstrating a degree of versatility and supporting the party policy of strengthening outlying educational institutions by bringing in able energetic young men. Other alumni become senior designers and some, Gurevich and Yakolev for instance, have gained great reputation.

The Air Academy graduates play a fundamental role in setting the design philosophy of the Soviet aviation industry, either by designing prototypes or by

*Leon Trilling, assistant professor of Aeronautical engineering at Massachusetts Institute of Technology.



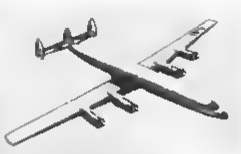
Lockheed Electra—equipped with a Honeywell Transistorized Fuel Gage

Martin RB-57B Canberra equipped with a Honeywell Transistorized Fuel Gage

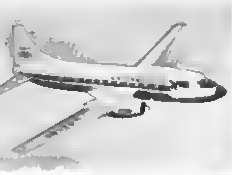
Fairchild C-119—equipped with a Honeywell Vacuum Tube Gage.

Douglas DC-7C—equipped with a Honeywell Transistorized Gage

Lockheed F-104A Starfighter equipped with a Honeywell Transistorized Fuel Gage.

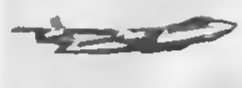


Lockheed 1649A Super Constellation—equipped with a Honeywell Transistorized Fuel Gage



Convair 440 Metropolitan equipped with a Honeywell Vacuum Tube Gage.

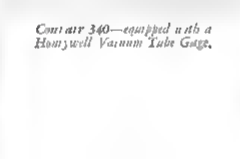
Martin XP6M-1 SeaMaster equipped with a Honeywell Transistorized Fuel Gage.



Boeing B-47—equipped with a Honeywell Vacuum Tube Fuel Gage.

Cessna 620—equipped with a Honeywell Transistorized Fuel Gage

Douglas DC-6B—equipped with a Honeywell Vacuum Tube Gage.



Convair 340—equipped with a Honeywell Vacuum Tube Gage.

Cessna T-37A—equipped with a Honeywell Vacuum Tube Gage.

Vertol H-21—equipped with a Honeywell Transistorized Fuel Gage

Lockheed C-130A Hercules equipped with a Honeywell Vacuum Tube Fuel Gage

Convair XFY-1 Pogo—equipped with a Honeywell Vacuum Tube Gage.

Lockheed 1049G Super Constellation—equipped with a Honeywell Vacuum Tube Gage.

Martin P5M Marlin—equipped with a Honeywell Transistorized Gage.

Grumman F11F-1 Tiger equipped with a Honeywell Transistorized Fuel Gage.

Sikorsky S-56 Helicopter equipped with a Honeywell Transistorized Fuel Gage.

Lockheed T2V-1 SeaStar equipped with a Honeywell Transistorized Fuel Gage.

Avro CF-100 Canuck—equipped with a Honeywell Vacuum Tube Gage.

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MINNEAPOLIS **Honeywell**

AERONAUTICAL DIVISION

writing the specifications to which prototypes are built. They are prepared for that important responsibility both by a thorough, up-to-date, broad technical education and by an indoctrination program which not only stresses loyalty to the regime but apparently also installs pride, esprit de corps, and a sense of leadership and responsibility.

Basic research is not the administrative concern of the universities or of the Ministry of Higher Education. It is primarily the responsibility of the Academy of Sciences of the Soviet Union, a body made up of the leading scientists in all fields of research and development which reports directly to the Council of Ministers and is assigned a large annual budget to sponsor research at a number of Academy research institutes.

However, the separation between universities and research institutes is more apparent than real, since the same man may in the morning lecture at the university and in the afternoon supervise research in the same field at a research institute.

This "multiple hat" system in which leading academic personnel carry several responsibilities appears from the available testimony to operate with flexibility and effectiveness.

Scientists engaged in the fundamental research which underlies the whole problem of flight do their work both at the universities and at the Academy-sponsored research institutes, where they are faculty or research staff members. The younger staff members are research engineers and aspirants or graduate students who act as part-time research assistants; the others spend part of their time as docents or professors and part as research fellows or senior research personnel.

It is apparently almost a universal rule that the time of the academic personnel is divided between teaching duties and research. All in all, they form a numerically small privileged group in the Soviet Union and enjoy high prestige and an excellent standard of living, with high earnings, eight weeks of yearly paid vacation at a designated resort and other advantages.

Compared to a worker's wage of about 800 rubles per month, the monthly pay scale for academic personnel is as follows:

- **Civilian Institute or University**—Assistant 900/1200 rubles. Docent, 1300/1700 rubles. Professor 1700/2100 rubles.
- **Military Institute**—Assistant 1500/1700 rubles. Docent, 2000/2400 rubles. Professor 2000/2400 rubles.

In addition, there is a 20 per cent bonus if the individual has the title *Kandidat Nauk*, an extra 10 per cent for the title *Doktor Nauk*, and an extra 300 to 500 rubles for administrative responsibilities for laboratory heads or professors in charge of a chair. It appears from this table that the income of an academic worker is two to five times that of an industrial worker.

Furthermore, since it is standard practice to hold at least two jobs simultaneously, and the attendance regulations (especially for senior staff members) are not strict, it is possible (and usual) to draw two salaries. A senior professor in charge of a laboratory might thus draw up to 7000 to 7500 rubles per month, and his consulting and book-writing activities may boost the total still higher.

Salaries Doubled

The figures quoted above are as of 1948. Apparently they have all been approximately doubled since, presumably in connection with the revaluation of the ruble.

Note the significantly higher pay rate at military institutes, an additional indication of the select place which they occupy in the over-all scheme.

While assistants work an eight-hour six-day week, docents and professors have a maximum work load of four lecture hours and four consultation hours per week, the rest of their time being taken up by research, administrative work (including sitting on numerous academic and government committees), and consulting.

It is the rule for a docent or a professor to prepare his own course rather than follow a specified textbook step by step. This involves the preparations of notes which frequently end up by being published as textbooks. The practice of writing textbooks apparently approved by the state, is both an appreciable source of revenue for academic personnel and, in view of the great difficulty of publishing research papers, the best means of making themselves known.

The present policy (at least in technical fields) appears to be to encourage the publication of a number of textbooks of slightly different viewpoints, and the number of texts in any subject tends to be quite large. (Five on advanced applied aerodynamics are known to this writer.) There is also much writing of monographs and treatises.

Because of the scarcity of available official information on the technical content and quality of the education of a Soviet scientist engaged in teaching and research in the manner just described, the discussion which follows is limited to an analysis of certain advanced course Soviet textbooks and some observations on the range of activities of graduates of a particular chair, namely, the Chair of Fluid Mechanics.

Of the numerous textbooks examined

in the course of this study, two were selected to orient the discussion both because they illustrate Soviet research in theoretical fluid mechanics and because they are quoted often enough in the technical literature to indicate that they are in fact part of the technical baggage of most of the younger scientists. They are *Theoretical Hydromechanics* by Kochin, Kibel and Rose; and *Mechanics of Continuous Media* by Landau and Lifshitz.

In general, in order to absorb the material presented in the two basic monographs a student must have an excellent knowledge of classical mathematical analysis, probably the equivalent of what an advanced graduate would obtain in the United States, a broad view of the laws of analytical mechanics and their application to a number of widely different physical situations, and, last but not least, considerable sophistication and maturity in the handling of his mathematical tools.

Specifically, *Theoretical Hydromechanics* outlines in great detail the principal mathematical methods of use in fluid mechanics: functions of a complex variable, expansions in orthogonal functions, method of characteristics, numerical methods, and so on. Each technique is illustrated by exhaustive application to one or several selected problems of practical interest which are treated thoroughly enough to allow engineering applications.

Mechanics of Continuous Media shows the range of applications of the science of fluid mechanics by presenting typical problems in the fields of aeronautical, mechanical, hydraulic, and chemical engineering; in meteorology, acoustics, oceanography, geophysics, astrophysics, low temperature physics, and chemistry. This astonishing breadth precludes detailed treatment of any single subject but gives the reader an insight into the units of the field which underlies all the applications and suggests why fruitful analogies and ways in which techniques may be grafted from one application onto another.

Certain solutions for supersonic flows past cones, first studied in Germany in 1942 and in the United States in 1946, for instance, were noted in the Soviet Union as simple applications of a solution of a geophysical problem involving a completely different physical background. (Smirnov and Sobolev—1932)

It should be noted that both skill in mathematics and a broad outlook in classical mechanics have been part of the Russian scientific tradition since well before the Revolution and were applied with success to many problems in fluid mechanics and aeronautics by N. E. Zhukovski (1847-1921) and his principal student, S. A. Chaplygin (1869-1942). Both of these men

reached maturity and occupied positions of influence in the Imperial university system, and their labors laid the basis of aeronautical research and development in Russia before and after the Revolution. The tradition of mathematical skill and versatility is preserved to the present day in the Soviet Union, as some examples will show.

Three Men Selected

Among the senior teaching and research personnel, three men may be selected as typical of the Soviet effort in theoretical fluid and gas dynamics. L. I. Sedov (born around 1895) is an applied mathematician with a dazzling technique. He was connected with TsAGI in the 1930's and has been a professor of mechanics at Moscow University since the late 1930's and a member of the Academy since the 1940's. He has made significant contributions to the theory of the lift of wings (1932-1937), of ship wave motion (1937), and of the impact of hard bodies on a free water surface, both singly (1934) and with several students (1950-1953). When high-speed flight became a practical prospect, he attacked the aerodynamic problems which it raised, at first with limited success (1937-1940).

In 1942 he gathered a group of young scientists who, under his guidance, worked out the general theory of supersonic flight of thin wings and bodies (1942-1946). He has since shown a fleeting interest in turbulence (1942) and has undertaken a searching study of dimensional analysis and similarity in mathematics and physics, applying his results to the problem of very strong blast waves (1940-1952). He was appointed chairman of the Academy commission for an earth satellite and, as such, represented the Soviet Union at the recent international astronautical conference in Copenhagen.

S. A. Christianovich (born in 1908), a star pupil of S. A. Chaplygin, did his first important work in 1935-1942, an extension of Chaplygin's calculation of gas jets so that it could be used to determine the performance of wings of any shape at speeds nearly up to the speed of sound. He played an active part in wartime research and has since taken the role of a senior statesman in fluid mechanics, a position bolstered by his recent election as chairman of the technical section of the Academy.

Christianovich Papers

Christianovich has in the last five years presented or sponsored papers on subjects of interest in chemical engineering (Gas Flows in Pipes with Heat Addition and Suspended Particles—1950), electrical engineering ("Problems related to the Construction of the Kuibyshev Power Plant"—1953), mining engineering (Effect of High Pressure Pockets on Rumbling of Coal).

V. V. Golubev was born in 1884 near Vologolamsk, where his father taught Latin in a parochial school. After a brilliant secondary school education during which he showed an interest in mathematics and the natural sciences, he entered Moscow University in 1903 and graduated in 1908 in mathematics. He then divided his time between research, graduate study at the University, and teaching simultaneously at several public and private high schools, and obtained his master's degree in mathematics in 1915. In 1917 he was appointed Professor of Mathematics at the University of Saratov (founded in 1909 and later vastly expanded), where he became Dean of the Mathematics-Physics Department in 1918. Just then, as he was readying a doctoral dissertation on singular differential equations, all academic titles were abolished (1919).

Circumstances then forced him to take an interest in less abstract researches, and in 1924-1927 he began a study of lifting wing theory. After 1920 he also taught mathematics at the Saratov Institute of Agricultural Science and he eventually published his lectures "Principles of Mathematical Statistics Applied to Forestry" (1930).

In 1930 he joined the research staff

of TSAGI and was appointed Professor of Hydromechanics at Moscow University. In 1932 he received a concurrent appointment as Professor of Mathematics at the Zhukovsky Military Air Academy, and in 1939 he was given a suitable rank in the Red Army. His simultaneous connection with the Hydromechanics Chair at Moscow University, the TsAGI research staff, and the faculty of the Zhukovsky Military Air Academy illustrates the "multiple hat system"—which kept him in a well informed and influential position in several activities of the air development program. In 1941 he left the TsAGI staff and was appointed to the University of Sverdlovsk, where part of Moscow University had been evacuated. In 1946 he became Dean of the Mathematics-Mechanics Department of Moscow University and a member of the Mechanics Institute of the Academy of Sciences. He died in 1954.

Judging by the evidence of technical publications it seems that versatility is also found in the new generation of Soviet fluid dynamicists. In the preface of her book, *Wings of Finite Span in a Compressible Stream*, E. A. Krassilshchikova describes how, in 1942, L. I. Sedov gathered a group of young scientists to form a seminar in supersonic wing theory. The three senior members of the group were F. I. Frankl, an Austrian refugee who had been in the Soviet Union since 1933, who was also leading his own subgroup to brilliant discoveries in transonic flow theory; S. V. Falkovich, who had just obtained his *Doktor Nauk* degree from Saratov University with a thesis on soil seepage and water filtration, and M. D. Haskind, who had published a number of papers on ship oscillation dynamics.

Younger Members

The younger members of the team included A. A. Nikolski, G. I. Taganov, M. I. Gurevich, L. A. Galin, E. A. Karpovich, I. A. Panchkin, and Krassilshchikova. After the completion of their task (and possibly the easing of some wartime security) the group published a series of seventeen papers and two books in 1946-1947. (Coincidentally, this great burst of publications was part of the celebration of the hundredth anniversary of Zhukovsky's birth and of propaganda activities related to the Jubilee of the Academy of Sciences.)

Sedov's later career has already been outlined. Frankl's took an abrupt turn. Frankl, an applied mathematician interested in aeronautical problems, was on the faculty of Moscow University and on the research staff of TsAGI from 1933 to 1941. When TsAGI was transferred to Novossibirsk, he became a professor at nearby Tomsk University. After the war TsAGI headquarters was returned to the Moscow area, and he rejoined the faculty of Moscow University. Since 1952 he has been a professor at the Kirghiz State University, his research bearing on sedimentation in mountain streams and on some questions of the theory of relativity. Why a professor at Moscow University would "compete" for an appointment at the Kirghiz State University was a mystery until a reliable witness stated that the man's loyalty to the regime had been questioned after a friend's arrest.

Hypersonic Flow Problems

Falkovich, after completing his work in soil seepage mechanics, has become involved in hypersonic flow problems (problems of flight at very high altitude and very high speed). Haskind has returned to problems of ship dynamics, on which he has published a dozen papers since 1947. After his stay in Moscow he went to Nikolaev, and he has been at Odessa since 1954. Among the younger group, Nikolski has divided his time between extensions of his war time work on transonic flow and studies of explosions in coal mines due to high pressure gas pockets. Taganov has not been heard from; Gurevich has continued to assist Sedov; Galin has applied some of the techniques developed in the Sedov seminar to problems of impact dynamics, seepage and plasticity; Karpovich and Panchkin have not published any work. Krassilshchikova alone is still concerned with supersonic wing theory, of which she has given some interesting extensions. By and large, the Sedov supersonic aerodynamics task force has been dispersed.

The conclusion suggested by the foregoing career summaries is that the education given in the field of theoretical fluid mechanics in the Soviet Union trains young people to take a broad view of basic principles and to apply them in a number of physically unrelated situations. It also appears that it is the conscious policy of the Academy to foster the task force approach and to stand ready at any time to form task forces of scientists to "launch the struggle" against whatever bottleneck is considered most serious to the over-all research effort. In 1942 Sedov's seminar constituted a task force of that type to attack supersonic flow, other task forces have been launched on the boundary layer problem (1938-1942) and jet engine design problems (1947-present).

The task force approach tends to give a spasmodic, scattered appearance to some of the Soviet research and it emphasizes immediate applications to short range aims—to the possible detriment of fundamental long-range research. At least one observer (Bock) suggests that as long as research in the West has enough lead to indicate what the significant problems are, the Soviet

task forces will be able to solve those problems as rapidly and effectively as Western groups; but he questions the ability of the Soviet research apparatus to uncover and formulate new problems. Soviet performance in developing transonic aerodynamics ahead of the United States and linear supersonic aerodynamics independently of the United States suggests that such a view may not be justified.

In any case, the availability of high quality versatile research personnel and the application of their skill to whatever practical problem is most pressing indicate an efficient and, for the present, generally successful planned use of scientific manpower by means of what has been called above the 'multiple hat system."

As a consultant to the design team, the senior scientist becomes familiar with the problem; as a member of an Academy committee, he agitates for the formation of a research group, as a professor senior laboratory staff member, he is in a position to help recruit and direct a research group generally assembled under his chair. And the younger man learns the facts of the relationship between research and production and broadens his experience by taking part in the work of the task force until he becomes mature enough to lead one.

This Soviet method of managing scientific manpower, which stresses versatility in application, is particularly suited to theoretical investigations. It is much easier to adapt a mathematical formula to fit a new physical problem than to develop an experimental technique. There is evidence that in the field of fluid mechanics much greater reliance is placed on theoretical research in the Soviet Union than in most Western countries because it is easier and less expensive to develop the required staff and equipment and because, apparently, this approach is traditionally much more congenial to the Russian scientist.

Soviet progress in theoretical fluid mechanics is generally impressive. Soviet scientists have contributed their full share of new ideas, and they are abreast of their counterparts in any other country. On the other hand, examination of textbooks and published papers on experimental research indicates that while the techniques developed in Germany, Britain, and the United States up to 1952 are known to the Soviet scientists, they have not sought new techniques and have used the imported techniques more for routine testing than to attempt to break new ground by means of fundamental experimental research.

The task-force system infringes on the local independence of universities and

Parachuting Behind the Iron Curtain

Scenes at Third World Parachute Championships witnessed by some 100,000 Muscovites at Tushino Airport recently. Czech parachutist (top left) pulls ripcord with right hand immediately after leaving An-2 Colt transport used for jumps. Note pilot chute already starting to fill, jump targets below, city of Moscow across river in background. Americans (bottom left) poised for jump from An-2. Jack Andre Istel of Air Associates Teterboro Airport, is standing in aisle. Several practice jumps were made to familiarize contestants with speed, characteristics of aircraft. Soviets' Ivan Fedchishin (right) ascending to take first place in men's 1,500 meters jump with free fall of 20 seconds. Note open panel, steerable chute. Soviet team won meet.

interferes with their continuing long range research plans by drawing on their staffs at unpredictable times. It also disturbs the younger scientist's personal life and limits his opportunity to select the problems which interest him most. It may discourage his initiative since it puts the ultimate responsibility on relatively small committees of senior scientists who must correctly predict which problems will be of greatest practical importance in the years ahead and how those problems are best attacked.

Graduate Training

Graduate training leading normally in three years to the first academic degree (*kandidat nauk*), introduces the advanced student to research in his area of specialization. Those selected for graduate work (*aspirantura*) are called *aspirants*. An aspirant spends some part of his time taking advanced courses and keeping his ideology up-to-date, but the greater part of his effort is devoted to research in the laboratories of an institution which has graduate training programs. If his research thesis (defended before an examining committee appointed by the Ministry of Higher Education) is satisfactory, the aspirant receives the *kandidat nauk* degree. On the basis of age, length of time spent in school, and the content of theses, the qualifications of a *kandidat nauk* appear to be similar to those of a Ph.D. in this country.

Graduate training at the aeronautical institutes is offered in many fields, corresponding usually to the areas of research most strongly developed in a given school. In 1954 the two aeronautical institutes in Moscow, where some 250 aspirants are trained and some 30 become *kandidats nauk* each year, announced graduate courses in the following fields:

Ordzhonikidze Air Institute:
- Strength of materials.
- Machine design.
- Theory of mechanisms.
- Machine tools and cutting tools.
- Plant safety techniques.
- Design of electrical machinery.
- Physics and metallurgy.
- Descriptive geometry and drafting.
- Advanced mathematics.

Air Technology:
- Metallography and heat treatment of nonferrous alloys.
- Technology of foundry production.
- Technology of machining metals.
- Technology of instrument manufacture.
- Strength of materials.
- Technology of welding production.

The regulations for the awarding of the degree *Kandidat nauk* are strict. The candidate must pass a number of examinations on his course work and defend a thesis before a State Examining Commission. There is in addition a three year time limit to aspirantura (four years for correspondence students) which was apparently imposed because too many aspirants, particularly at universities, preferred the relatively sheltered if austere life of a student and, consequently, showed no eagerness to complete their theses.

It would appear from recent complaints in Soviet literature (*Vysshaya Shkola*, August 1955) that the time limit rule has not succeeded in increasing the number of completed theses but rather has made it possible to eliminate the "eternal students" and so make more of the professional time available to those who devote themselves to their work. Apparently, only between one-half and one-third of the aspirants ever complete their theses successfully, and of these only a fraction ever publish another paper.

If a *kandidat nauk* pursues an academic career, after from five to ten years and after publication of an important piece of research he may become a *doktor nauk*, eligible to compete for an appointment as a professor. The Soviet *doktor nauk* degree may be likened to a British Sc.D. or the German *habilitation*.

Research Institutes

It is important to note here that graduate training programs are maintained not only in a number of regular institutions of higher learning (universities, polytechnic, and specialized technical schools, e.g., aeronautical institutes and air academies) but also in a large number of research institutes maintained by the various ministries and by the academies of science.

Thus of the 216 institutions authorized—subject to normal certification by the Ministry of Higher Education—to grant Doctor of Science (*doktor nauk*) degrees, 72 (or one third) are not colleges or universities but industrial or Academy of Science research institutes. Since most of the 72 Academy and other research institutes and military schools are located in the Moscow or Leningrad area, the concentration of advanced training and research in Moscow and Leningrad is considerable, acting as a magnet on the brighter young scholars and tending to increase that concentration in spite of efforts by the government to reduce it.

The number of graduate students at Soviet technical schools is uniformly low, ranging from 2.0% of the student body at Bauman Technical School down to zero as compared to 40% at Caltech, 38% at MIT, and an average of 12% in American Technical schools. The Soviet situation may be the result of a deliberate policy which aims to get engineers into the industrial stream as quickly as possible and to enable the senior professors to educate the best

graduate as carefully and thoroughly as possible, for, because of the somewhat mechanical nature of the average engineering education, the leaders carry a heavy responsibility both as teachers and as senior research staff members.

The difficulties encountered in training enough graduate students to a sufficient peak of perfection are the subject of much concern at present in educational circles of the Soviet Union and, apparently, justly so, since the shortage of competent teachers is a major bottleneck in the expansion of the educational system.

Aircraft R & D

Aircraft research and development are concentrated largely at the specialized research institutes—such as the Central Aero- and Hydrodynamic Institute (TsAGI) and other institutes of the Aircraft Production Ministry. But research done by the faculty members and graduate students at the polytechnic institutes and at the military academies (such as Zhukovskii Air Academy in Moscow) is also a very important factor in the growth and development of Soviet competency in aeronautics. In a number of fields research task forces using the facilities and the leadership provided by polytechnic institutes, for instance, have contributed important results in the development of specific pieces of equipment or in the solution of specific technical problems in the field of aeronautics. To illustrate this activity, one may consider the work of L. G. Loitsianskii, Professor of Mechanics at the Leningrad Polytechnic Institute.

Mechanism of Drag

L. G. Loitsianskii is of the same generation and academic background as L. I. Sedov of Moscow University.

During the 1930s Loitsianskii was associated with TsAGI, taking a leading part in their studies of the mechanism of air resistance or drag. A German aerodynamicist, L. Prandtl, suggested in 1904 that a major portion of that drag is due to the viscous friction of the air in a very narrow layer near the solid surfaces along which it flows (boundary layer).

The practical importance of Prandtl's idea was just being generally appreciated about 1925 (possibly somewhat later in the Soviet Union); and it became Loitsianskii's task, first at TsAGI and after 1935 at the Leningrad Polytechnic Institute, to develop practical methods of calculating the flow in the boundary layer. Between 1941 and 1943 Loitsianskii and a group of students published a dozen papers to outline their solution of the problem, which is an extension of a method proposed by Th. von Kármán in Germany in 1921.

Loitsianskii's method has the advantage of being applicable to a wide variety of problems and of being quite straightforward and reasonably accurate. It is therefore well adapted to engineering calculations and appears to be in general use in the Soviet Union, but it is unwieldy and not suited to the investigation of the effect of viscous forces on high-speed modern aircraft. This is not because Loitsianskii is incapable of more elaborate or fundamental analysis. His publications on turbulence and his textbooks show that he has the solid mathematical education expected of a Russian scientist, but his boundary layer theory was meant to be, and within its range of application is, an engineering tool within reach of the average designer.

Since the war Loitsianskii and a large group of assistants have undertaken a program of basic studies of the gas flow in turbines. This problem is far too complicated for a rational solution. A good deal of engineering sense and experimentation are required to bring out its essential features and to create an ideal model simple enough to permit analysis and realistic enough to serve as a basis for engineering estimates. Recent press releases have indicated that the Soviet aircraft industry has produced turbojet engines appreciably more powerful than those in mass pro-

duction in the United States at the present time.

While know-how and ideas from German and other sources have helped in this Soviet accomplishment, they would not have been absorbed and put to effective use so rapidly if native groups such as Loitsianski's had not mastered the fundamentals of the problem independently and prepared a sufficient number of engineers to extend and improve good borrowed ideas in an original and skillful manner.

In connection with such work it is essential to check experimentally the results predicted from various simplifying assumptions, since these are suggested by engineering intuition and must be discarded unless they give reliable estimates. And, indeed, some competent instrumentation has been developed and used in connection with Loitsianski's work, especially the later work on turbines.

Although the Soviets are generally close-mouthed about their aeronautical testing equipment, they have recently described some optical apparatus and some fast-acting pressure pickups which indicate an ability to perform accurate measurements under difficult physical conditions.

The inevitable reliance on experiment makes it difficult to organize engineering development task forces similar to the theoretical groups described previously. The Soviet development engineer is more closely linked with his equipment and his versatility, while surprisingly great in a few leaders like Loitsianski, cannot be compared with that of an applied mathematician. Nevertheless, the research personnel at Soviet polytechnic institutes who contribute to the study of basic engineering concepts underlying aircraft propulsion are doing their jobs with imagination, competence, and apparent success.

Flow Techniques

An indication of the quality of the research done at the Zhukovskii Academy is given by a recent booklet published by A. N. Zaks on flow visualization techniques (1950) which describes the quality and type of equipment available there for experiments in aerodynamics. Zaks, who graduated from the Academy in the late 1940's, discusses some of the wind tunnels and optical instruments available at the Academy and shows photographs of simple tests carried out there.

Facilities in which speeds up to twice the speed of sound are reached were evidently in operation in the late forties, and adequate instrumentation was also in use. The Zaks booklet and other stray references in the Soviet literature suggest that the experimental equipment available at the Academy is kept fully up-to-date and as good as

Soviet technology can make it.

The work load, strain of frequent examinations, and unusually severe political supervision apparently take such a heavy toll of the students that only about a quarter of admitted cadets graduate. In one case where firsthand information is available, only six out of a section of twenty two finished the course. Soviet wastage here appears higher than the average graduate school wastage. Since the cadets hold a commission in the Red Air Force, failure means assignment to a military post in the field.

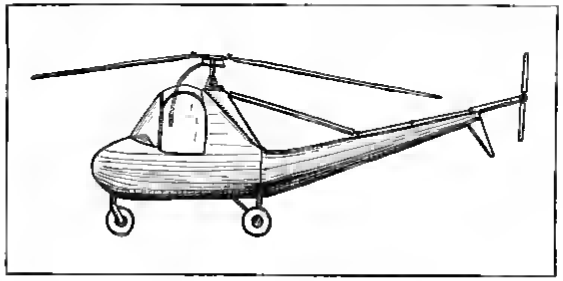
Those students who graduate assume positions of responsibility in the technical planning of the Air Force. In at least two instances, sufficient technical publications are available to form an objective opinion of the ability and training received at an air engineering academy.

Professor A. P. Melnikov received his degree of Doctor of Technical Sciences from the Leningrad Air Engineering Academy (in 1942) with a thesis presumably done under Professor Loitsianski in which he works out an original application of Loitsianski's boundary layer method to the problem of designing a wing of reduced air resistance. He has apparently continued this work and presented new significant results at the Third All Union Applied Mathematics Congress in 1953. He is evidently a competent applied scientist with good engineering sense.

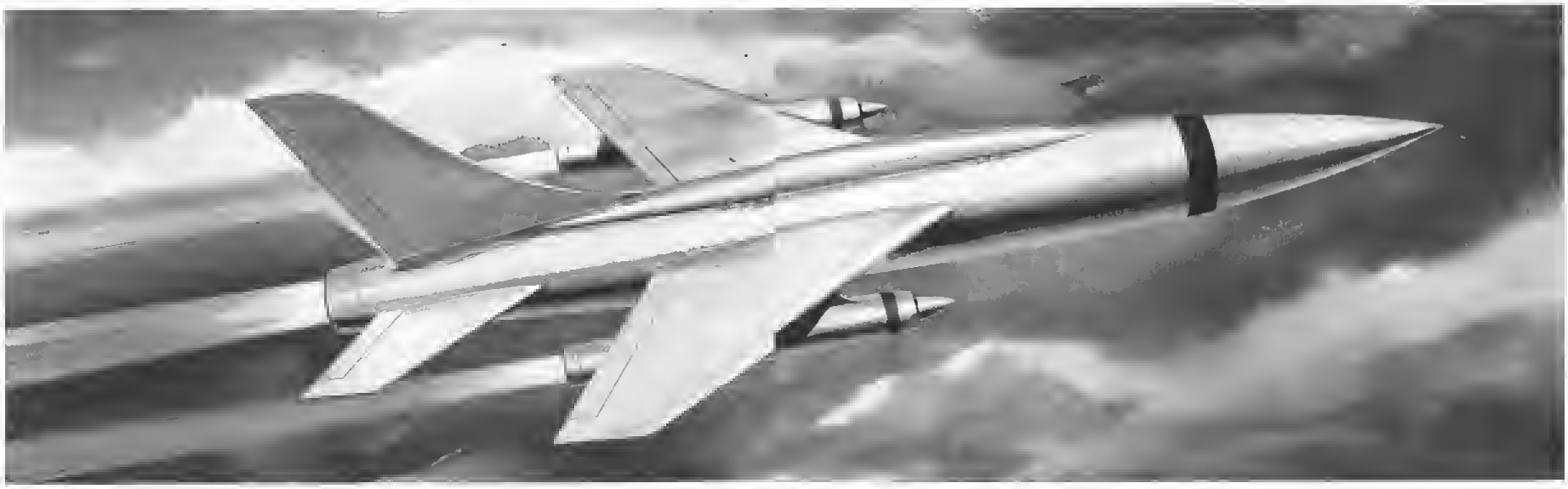
Shortly after his graduation from the Zhukovski Academy in 1952, A. N. Zaks published a textbook on Applied Aerodynamics which displays a thorough knowledge of developments in his field, both in the Soviet Union and abroad, and the ability to organize his material clearly and to emphasize the points likely to be significant in the future, on the basis of that book one may also consider him a thoroughly qualified aeronautical engineer.

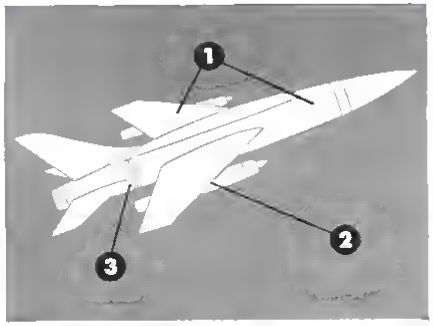
Drawing Forecast Czech Helicopter

From a photograph of only the tail rotor of a new Czech helicopter, Eugene K. Liberatore, a helicopter expert, was able to make a drawing for Aviation Week of the entire machine (AW April 23, p. 65). How close he came is readily apparent from the photograph of the same machine provided by Ralph W. Kummer, public relations manager of Hiller Helicopters, after he saw the drawing. A Czech interested in VTO sent Kummer the picture. The helicopter, designed by a group under Jaroslav Sleichta at the Research Institute of Aviation, is derived from the Sleichta XE-11. Powerplant of the two-seater is a Praga G four cylinder engine rated at 80 hp. Gross weight is 1,234 lb. Top speed of 75 mph., rate of climb 200 fpm. and ceiling of 10,164 is claimed. Liberatore correctly projected the overhanging stick control, three-blade single rotor, the general landing gear form and entire configuration.

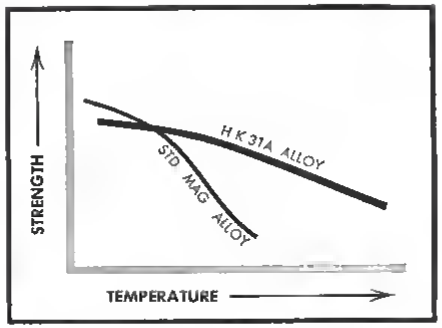


NEW DOW MAGNESIUM ALLOYS CRACK HEAT BARRIER!





Now suggested *for a broad range of uses in missiles and aircraft, the new Dow magnesium alloys are available in the form of (1) sheet or plate, (2) extrusions, (3) castings.*



Maintenance of strength *at high temperatures is illustrated by this chart. Performance data on the new alloys at elevated temperatures can be obtained by request.*

High temperature magnesium allays are available ta lighten aircraft and missile structures

Once again the horizons for aircraft structural design have been widened. Dow has developed a series of high temperature magnesium alloys which are already in pre-production use on aircraft, missile and engine structures. These alloys show advantages at temperatures up to 700° F. Limited test data on properties up to 800° F. are available for some of these alloys.

The new alloys save precious pounds because of their good combination of modulus and properties, including creep strength, at temperature. Shop characteristics include good formability and weldability.

One of the available alloys is the magnesium-thorium composition, HK31A, which is manufactured in rolled and cast form. Under development is a similar alloy for extruded shapes and forgings. HK31A sheet and plate are available from stock and from current mill delivery schedules in standard sizes from 0.016″ to 2″.

These new magnesium alloys by Dow should be considered for your high temperature requirements. Contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Magnesium Sales Dept., MA 361G, Midland, Michigan.

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Space Navigation Challenges Engineers

By Peter A. Castruccio

Baltimore—Space, where the absence of atmosphere insures that electromagnetic waves will not be bent, deviated or attenuated, offers an ideal medium for the electronics engineer.

At the same time, the problems of guidance, navigation and communications for future space travelers, and enemy spotting and tracking, fire control and special communications in the event of space wars challenge the electronics engineer.

At first glance, the problem of space navigation appears rather simple because the position of celestial bodies can be accurately predicted. It should merely be necessary to establish an accurate course from the base of departure to the future position of the particular destination desired, taking into account the various forces acting upon the craft.

However, in practice space navigation is made quite difficult by the exactness and accuracy required. A course such as the one described requires not only the exact knowledge of the position and trajectory of celestial bodies, which indeed is very accurately calculable, but it also requires an equally precise knowledge of the not so easily calculable initial direction of travel of the space ship and its velocity.

Extreme Accuracy Needed

An idea of the accuracy involved is indicated in the following example: assume a voyage to the planet Mars is timed to intercept the orbit of that planet at its nearest distance to the earth, which is on the order of 36 million miles. For spaceship speeds of about 12 mi. per second, an error in launching angle of one second of arc would result in a positional error at the end of the trajectory of 500 mi. When one considers that an error of one second is of the order of magnitude of error of the best theodolites under conditions of good observation, one can visualize the difficulty of maintaining a ship to any given trajectory within this order of accuracy.

A more likely error for a very accurate launching system is in the order of a minute of arc. This will yield a final error of 30,000 mi. Assuming that the trip is performed with initial speed of 12 mi. per second, an error in initial velocity of 1% would cause an error at the end of the trajectory of about 500,000 mi. Errors of this magnitude, small compared to the distance traveled, would cause additional fuel consumption at the end of the trajectory in order to place the ship in the correct final orbit.

Early spaceships will have no choice other than to follow very accurate orbits due to the relatively low efficiency of chemical rockets, but better fuels and engines will be developed to give a large degree of freedom in chosen flight pattern. We thus envision two stages in the progress of space navigation:

- **Stage 1**—Chemically powered ships venture on occasional, carefully timed exploratory expeditions.
- **Stage 2**—Gradual increase of regular 'space lines,' and the advent of rather heavy space traffic.

During Stage 1, space navigation will be almost exclusively optical, with the eventual existence of earth-based computers linked to the space ship by radio. In Stage 2, we will witness the development of automatic navigation aids.

The Author

Dr. Peter A. Castruccio at the age of 21 won his doctorate summa cum laude in electrical engineering in 1946 from the University of Genoa, Italy. Born in New York City, the son of a diplomat, Dr. Castruccio served in the British Secret Service during World War II, performing intelligence missions behind enemy lines at the age of 19. Twice captured, he was under death sentence at the time of the war's end.

Returning to the U. S. in 1946, Dr. Castruccio joined Bendix Radio, later the Glenn L. Martin Co. At the present time Dr. Castruccio is an advisory engineer in the missile sub-systems engineering group of Westinghouse Electric Corp. Air Arm Division, Baltimore.

Navigation involves a knowledge of one's position and one's velocity vector. In space these quantities are characterized by three parameters each or six parameters in all. In purely celestial navigation the various heavenly bodies in conjunction with optical instruments are sufficient to determine one's positive position and velocity.

Absolute Position

Observation of the stars is not sufficient to obtain positional information because the stars are so far away that for all practical purposes they are points at infinity. The only information that can be gathered from star observations in space is the direction of the radius vector from the origin of the coordinate system to the ship. To determine absolute position, the magnitude of the radius vector must be known. This can be done with a reasonable degree of accuracy by measuring the apparent diameter of the sun. If we assume an error of one second of arc in measuring the sun's apparent angular diameter, and further assume the ship is at a distance from the sun equal to the earth's distance (approximately 100,000,000 mi.) the resulting error in the magnitude of the radius vector so determined is of 100,000 mi.

Another method of navigation is to perform observations on the planets instead of the stars. This method will yield absolute position with greater geometrical accuracy than the star-and-sun diameter observations, but it requires an accurate knowledge of the position of the planets at any given time. This involves the use of a clock aboard ship.

Observation of the planets for navigation within the orbit of Mars with instruments capable of accuracies of a second of arc and a clock accurate to a hundredth of a second would mean, in most cases, positional errors of the order of 1,000 mi. This indicates navigation by celestial bodies can be quite accurate and would certainly enable the space travelers to find their destination.

Radar Techniques

Guidance can also be obtained by the use of radar techniques. Thus, beams similar to those used in radio navigation of aircraft could be established in space.

The principal difference between present-day beams and space beams is that earth based beams are fixed with respect to an earth frame of reference, but space beams will of necessity move with respect to the solar system's frame of reference. This complicates the problem because both the guiding beam and the guided ship move relative to the point of arrival. Nevertheless, such a beam system still could be conceived in several forms:

- **Beams aimed between planets**, forming polygons of variable sizes, the sides of which represent shortest geometric distances between planets.
- **Swept beams** which cover periodically a large section of space.
- **Broad or omnidirectional beams** which provide an intercept course and open the possibility of a proportional navigation system.

Of these possibilities, the first appears interesting because it would allow the spaceship to operate in much the same fashion as a beamrider missile. The beamrider is a very convenient system for guidance, but it displays several disadvantages such as a longer, and therefore uneconomical, flight path and extremely high terminal accelerations. This form of guidance is definitely reserved for the fast spaceships of the future.

Also, it could not guide the ship all the way to its destination planet, but would require a terminal phase of guidance because of the high terminal accelerations required.

Using the third approach, the beam would be located on the base of arrival, and the ship could navigate in much the same fashion as an interceptor (proportional-navigation) homing missile.

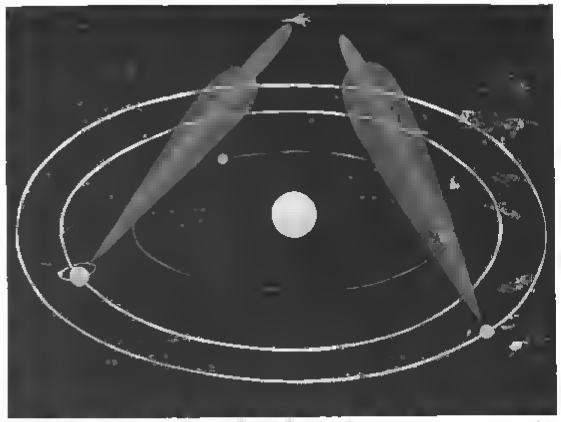
This type missile automatically follows the shortest straight line course to the target. In such a case, the beam would need to be broader than in the previous cases, and possibly it could be an omnidirectional radiating source. Navigation in this case would at least be simple in theory. The ship's pilot would select the particular frequency corresponding to the destination point, and the automatic mechanism within the ship would do the rest, always maintaining the ship in a shortest-distance collision course.

The source of the beam could be located on the planet of arrival, or on a satellite of the planet—either artificial or natural. Because of the rotary motion of all these bodies, the beam would have to be rotated in synchronism. In the case of an omnidirectional radiator, several would have to be installed on the surface of a planet so as to avoid casting a shadow when the beacon is turned away from the ship.

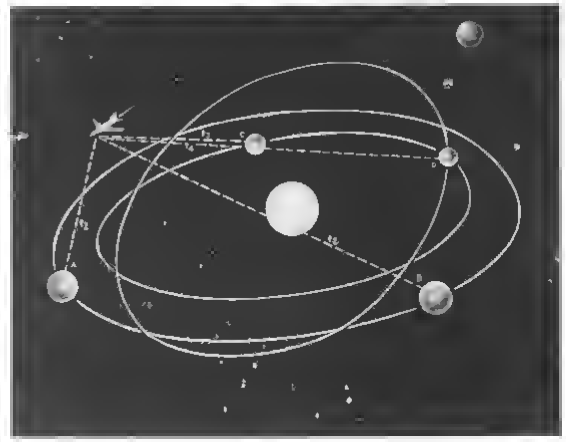
An antenna of 30 ft. diameter operating at a 3 centimeter wave length (X band) could theoretically guide a ship from an Earth base to Mars at its closest distance with an accuracy of 10,000 mi. This compares very favorably with accuracies quoted for celestial navigation, however, it is probably an unnecessarily high accuracy.

Basic problem of beam guidance is range. Range can be increased by narrowing the beam, but the beam becomes more difficult to locate by the ship. An idea of the range achievable with predictable techniques can be obtained by considering that a transmitting system sending a beam 24 deg. wide with a power of 10 kw. average will have a reliable range of about 140 million mi., assuming a receiving antenna 10 sq. ft. in area and a very good (1 db.) receiver.

Greater ranges can be obtained by increasing the gain of the receiving antenna by the simple expedient of increasing the frequency. Thus, if receiving and transmitting antennas possess 24 deg. beam, the maximum range could be increased to 2.1 billion miles, satisfactory for traffic within the orbit of Uranus. Even an unskilled navigator equipped with maps and optical instruments would be able to effect a crossing



RADAR BEAMS, like those used for missile guidance, might be employed for space navigation, permitting automatic guidance of vehicles to within 10,000 mi. of destination.



LORAN-TYPE system, using four omnidirectional beacons installed on planets or satellites whose orbits around sun are known, is another possible approach to space navigation.

with the beam, and then be guided by the beam.

It should be noted that use of the beam will yield a direct measurement of the ship's velocity with respect to the source of the transmitted energy by employing the doppler effect, provided the frequency of the beam is known.

Another navigation system employs beacons and is similar to the presently used Loran (long-range navigation) system, except that Loran operates in two dimensions and the space navigation system must operate in three. (See sketch, p. 83) Thus, at least four omnidirectional transmitting beacons could be set up in known orbits around the sun. Position of the ship within the Solar System can be determined by measuring the differences in times of arrival of pulses issued by the four beacons, which would have to transmit pulses synchronous in time similar to the Loran system.

Difficulty for space navigation is the requirement that this system be omnidirectional, limiting range compared with directional beams. An omnidirectional beacon transmitting an average power of 10 kw., used with a 10 sq. ft. receiving antenna and a good receiver, displays a reliable range of about 10 million miles. This range is far too limited for interplanetary flight.

Better Techniques

Future advances in communications techniques should improve this situation. For example, it is known that the noise generated within a receiver limits its ability to discriminate between signal and external noise, thereby cutting its sensitivity. It is also known that this internally generated receiver noise is reduced when the temperature of components is reduced. Making use of the very low temperatures of space, it should be possible to cool a receiver sufficiently to obtain a three-fold increase in range.

An additional advantage may be gained from the fact that interplanetary distances being very large compared to the speeds there is a greater length of time available to observe the signal. This situation presents an advantage over ordinary earth communications where time is limited to the high speed of aircraft with respect to the distance traveled. The longer the time to observe a signal, the better the signal can be distinguished over noise.

To utilize this advantage fully certain techniques are required which today are still experimental. If a time span of one minute is allowed for observation, receiver is cooled, and increased time is fully exploited, range can improve to 300 million mi. This range would be suitable for navigation within the orbit the Asteroids.

It is difficult at the present time to predict what advances in information theory can be expected, however, an estimate of an additional factor of 10 is not too far fetched. This would further increase range to 1 billion mi. entirely satisfactory for navigation within the orbit of Saturn. Even without such improvement, the further into space one goes the longer the time required for the trip and consequently the time for observation.

Since range increases approximately as the square root of the observation time, it becomes apparent that observation times of the order of 10 minutes would yield ranges of 1 billion miles. Besides, Solar Systems planet orbits all lie approximately in a plane. Thus, space navigation within the Solar System may well be confined within this plane, unless other noteworthy objects are discovered in other regions of space, an unlikely possibility in the light of our present knowledge.

Narrow Sector

Thus the beacon's radiation pattern need be omnidirectional in azimuth but confined to a relatively narrow elevation sector further increasing the beacon's range. If the vertical radiation be confined to a 10 deg. sector, a range of about 4 billion mi. could be achieved with 1970 techniques and with a 10 minute signal observation time.

It appears reasonable to predict that such a navigational system employing beacons will be feasible by the time space travel is accomplished. The beacon system will enable the spaceship to determine not only its position, but also its velocity vector by making use of the doppler frequency shift. The receiver would detect four different frequencies separately and be equipped with automatic means to measure the difference in arrival time of the four pulses and thus compute the position of the spaceship within the Solar System. Use of the doppler technique will also enable the ship to compute automatically its velocity vector. And so the ship can be automatically located in space.

It is possible, and perhaps desirable, to locate the beacons on planets or on satellites which already possess accurately known orbits.

Next problem facing the space traveler is communication, base-to-ship and ship-to-ship. Base-to-ship communications have the advantage that a very powerful station can be set up on the base for transmission to the ship.

Assuming the base to be equipped with an omnidirectional transmitter with a power average of 100 kw. and that the space ship carried a 10 sq. ft. receiving antenna, single sideband type voice transmissions should have a range in the order of 6.2 million mi.

Increasing the transmitter power

would help since range is proportional to the square root of the power, however, this "brute force" method requires base installations with power out of all proportion. For example, if transmitter power were increased to 2 million watts, the range would only increase by a factor of 4.5, yielding a total range of 28 million miles.

When one considers that the most powerful radio transmitters in the world today transmit about 1 megawatt one can visualize the tremendous powers required for such communication.

Omnidirectional communication, however, can be improved considerably by using beamed communication in which the transmitted power is sent out on a beam and reaches only the ships that are in the beam path. What is gained in increased range is lost in reduced coverage. By using a 24 deg. beam, and reverting to the 100 kw. power of the example, a range of 62 million miles could be achieved or 200 million miles with one megawatt.

Beam type communication requires either a knowledge of where the spaceship is, or requires sweeping the region of space where the ship is thought to be, until the ship is found. A three fold increase in the range can be obtained as previously explained, by cooling the receiver, but the factor of extended time reception will not be as favorable. In voice communications, it is desired to convey the message immediately.

Coded Communications

Telegraphic or code communications could wait for extended periods of time to achieve increased range. In this latter case, communication would be spread out in time, i.e., a message which would normally take one minute to deliver would require a considerably longer interval. If a one-minute message is spread out to one hour, an eight fold increase in range can be anticipated. A large antenna could be erected from the spaceship to capture more of the transmitted energy. In this manner, areas of perhaps 100 square meters could be achieved with a theoretical increase in range over the previous example by a factor of 10. With the cooling technique plus the auxiliary antenna technique, the range for communication could be increased to about 600 million miles with one megawatt transmitted power, which is a rather respectable figure.

Actually the ship is probably known to be lying in one octant with a consequent increase in range of a factor of 2.7, yielding a total range of about 1.6 billion miles. Again it is quite possible that future advances in techniques may further extend the range.

The situation for communication from the ship to the base is somewhat different. Unless future advances in

the art will make transmitted powers of the order of a 100 kw. or more practicable for ship-borne equipment, the spaceship is probably limited to much smaller powers than base stations. The ship, however, has the advantage that it knows where the base is and thus can employ the beaming technique.

Assume that the ship can conveniently carry a one kilowatt transmitter, then by using a 2 deg. beam, a range improvement of 125 times the omnidirectional case is achieved. At first sight, it appears that a one kilowatt transmitter with a 2 deg. beam width antenna would yield maximum range of 125 times 6.2 million miles or of about 2.2 billion miles. Such an improvement is predicted on having a one square meter or a 10 sq. ft. receiving antenna at the base.

Wave Length Size

If the transmitting antenna is to emit a two degree beam and have a reasonable size, the wave length should not be less than 30 centimeters. This means that the receiving antenna at the base will automatically become beamed (because its area is large compared to the wavelength) or must be reduced in size in order to give omnidirectional properties. This reduction in size means reduction in range.

Rather than reduce its size, it may be more practical to sweep the receiving antenna at the base and look for an intercepted signal. After all, at the base there is still a reasonable knowledge of the position of the spaceship, and thus some degree of beaming can be achieved. It should be noted that in the previous example (assuming a 100 sq. ft. antenna on the spaceship and a 2 deg. beam) the beaming required at the base with a 10 sq. ft. antenna, is only 15 deg., which may be entirely satisfactory in most cases. It appears then that ship-to-base communications can be obtained with reasonable means.

It is also entirely possible that nuclear energy may provide great sources of electrical power and that advances in the art may provide very light and compact transmitting devices capable of extremely high output power. It was noted that all the observations theretofore made are simply extrapolations of the present state-of-the-art into the rather near future, let us say within the next 10 to 20 years.

The next problem confronting space travelers is that of spaceship-to-spaceship communications. At the outset, communication between very distant spaceships seems rather pointless. Such communication can always be relayed through ground bases or beacons. It is also conceivable that in order to reach an outlying ship special transponder beacons may be set up. The first ship would aim at the transponder beacon

with its limited power but with a highly beamed antenna and deliver its message. The transponder beacon would then re-broadcast the message at high power.

This situation would rapidly lead to problems of assignment of transponder time as space traffic increased. Transponder beacons rapidly would become saturated, eventually only be used for emergency messages. Limiting ourselves to communications between reasonably close spaceships, let us see what can be achieved.

Assuming omnidirectional broadcast, a 10 sq. ft. antenna, one kilowatt of transmitted power, and voice communication, a range of 0.62 million miles can be achieved. With cooling of the receiver, the range can be increased to about 1.8 million miles. These parameters dictate a wave length of about 1.6 meters, corresponding to a frequency of the order of 200 megacycles. An increase in range can be had by increase in the transmitted power. If future advances will enable the ship to carry a 100 kw. transmitter, a range of 18 million miles could be achieved.

Beaming Techniques

Another considerable improvement can be obtained by employing beaming techniques. Of course, the beaming technique implies a knowledge of the position of the other ship. If there is no such knowledge, recourse must be had to scanning, which means searching successive regions in space and listening for a reply.

Scanning would be complicated in space because a considerable delay between transmission and reception would be experienced. The speed of light being 186,000 mi. per second, an interplanetary distance of 36 million miles as that between Earth and Mars at their closest point results in a delay of close to 4 minutes. Thus a complete round trip transmission between two space ships 50 million miles apart would take close to 8 minutes.

In order to establish contact, the transmitting ship would have to wait for duration of a complete round trip of a transmission plus a reasonable length of time to assure that the message was heard. However, this may be avoided by employing a memory of the successive antenna positions. In this manner the antenna could transmit its message say for one or two minutes in each direction, then move off to a new direction. If, six or eight minutes later, a received message appeared, it would only be necessary to have memorized antenna positions with respect to time to enable the transmitting ship to slew its antenna back.

It should be noted that beaming will involve higher frequencies than the HF and most likely it will require going into the VHF or microwave region in

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view of the limited space available for the transmitting and receiving antennas.

Although it now appears that the probability of encounter with meteorites is extremely low (so is the probability of colliding with another spaceship) it is interesting to investigate what might be done to avoid at least the large meteorites. An anti-collision radar would be difficult because of two factors:

- Small size of the meteorites
- Large frequency shift caused by doppler effect

Effective anti-meteorite radar must be able to protect the ship against fairly small objects. A one pound metallic core meteorite traveling at relative speeds of several tens of miles per second can cause considerable damage. Such a meteorite has a cross sectional area of approximately a tenth of a square foot. If the meteorite is irregular in shape and rock coated its radar cross section would be of the same magnitude as its geometric cross section.

Let us assume a tenth of a square foot as the radar cross section of the smallest meteorite which we desire to defend the spaceship against. It is well known that the radar range increases with the size of the antenna, but of course aboard the ship the antenna size will be limited. Let us assume a size of one square meter corresponding to a diameter of about 4 ft. It is also known that the higher the frequency of the radar, the higher the degree of beaming achievable and consequently the higher the searchlight. Let us assume that our space radar employs a wave length of 4 millimeters. Let us further assume that this radar employs a peak power of 100 kw. It should be noted that these parameters could probably be achievable within the next 10 to 20 years.

The next problem in radar design is that of bandwidth, which must be large enough to allow for the passage of information. It must not be too large or noise will also pass and tend to drown out the signal. In this connection the doppler shift enters the picture. Assuming a relative speed between ship and meteorite of 40 miles per second which is quite possible for a head on course the doppler shift at this wave length is of the order of 40 megacycles. This means that the receiver must be at least 30 megacycles wide because the doppler shift can occur anywhere from zero up to 30 megacycles depending on the relative speed between ship and meteorite.

The next step in our calculation is to assume a system loss. We are aware of the fact that every radar system performance suffers from losses in the transmitting and receiving elements, losses in the conversion element deterioration due to aging, etc. We will assume

here a figure of 6 db (meaning a loss of 4:1). It should be pointed out that this figure is unachievable today at these frequencies, but may be realized within the next 10 to 20 years. Today the very best that could probably be achieved at this frequency is 15 db, which means a loss of 30 to 1.

In order to be reliable, the signal must exceed the receiver noise by several times. This is particularly true in automatic radars, as this must be because an automatic radar must have a very high probability of not confusing the target with random noise. Again, we will assume that in order to be reliable, the signal must exceed the noise by at least 6 db (factor of four). This again is not achievable today but may be within the predictable future.

We now have all the elements to compute the range by applying the radar range equation. We find that the range of this radar is only 25 mi. Several things can be done now to improve this range. First we may use special circuits to recover at least partially the loss caused by the wide IF bandwidth. Assuming that this loss can be recovered completely, we find that the range improves to approximately 60 mi.

An additional improvement can be derived by cooling the receiver. In the case of radar, the improvement is not proportional to the square root of the cooling factor as in the one-way transmission, but only to the 4th root because of the two-way transmission. Assuming that the receiver can be cooled to 30 deg absolute, an improvement of about 1.6 results, yielding a range of approximately 100 miles.

Time Is Short

For a meteorite traveling head-on towards the ship at relative speeds of 40 mi. per second, this range gives us about 2.5 seconds to detect the target, plot its course, determine that it is a collision course, compute the ship's maneuver to evade the meteorite, and evade it. For meteorites traveling broad side to the ship at speeds of 20 mi. per second, the time to do all this is increased to about 5 seconds, a very short time to perform all these functions.

The situation is much better from the rear, assuming that meteorites pursue the ship. If the ship should travel at a speed equal to an average meteorite's speed, then it will leave the slow ones behind and will only be overtaken by the faster ones. These faster meteorites probably will only exceed the speed of the average meteorite by a few miles per second. This gives a possible span up to 1 min. to perform all maneuvers.

Thus in regions of space where the meteorite orbits and speeds are known, it is possible to protect against them by traveling in their direction and, of course, at sufficient speeds. Where the

direction and speed of the meteorites is unknown, it appears that the radar will provide practically no protection unless some major advances occur in the art.

We have assumed small targets of the order of a tenth of a square foot. Against larger targets the situation is only slightly better. Radar range increases as the fourth root of the target size so that even if we increase the target size by a factor of 100 giving us a 10 sq. ft. target, which corresponds to a 1,000 lb. meteorite, our range would only go up a little over 3 times. This increased range would be on the order of 300 mi. For head-on meteorites, a 300 mi. range radar would give us a warning time of about 8 seconds which still appears too short for all the things that must be done.

In view of the immensity of space, collisions between ships appear at first sight improbable unless we assume a very high traffic density confined to relatively narrow traffic lanes. Between ships, a radio warning system could be used which would have much greater ranges than the radar. Such a warning system could have the approximate ranges calculated previously for the case of ship-to-ship communications and thus even a relatively power ship-to-ship warning system could yield ranges of tens of thousands of miles.

Radar Mapping

Planetary mapping is of course best done by optical means. Only in cases where planets are covered by clouds either permanently or temporarily, such as Venus, would radar mapping be desirable and worthwhile. In addition to mapping, radar techniques can be used to some extent to determine the make-up of the planet's atmosphere. Different gases or combinations of gases possess different absorption characteristics at different frequencies. One could thus gain an insight into the constituents of a planet's atmosphere by measuring the weakening of the radar echo from a fixed point on the planet's surface as the radar frequency is varied.

An even better method would be the launching of a radar beacon transponder which could be parachuted to the planet's surface. This beacon would be equipped with a constant-power broad-band repeater which would retransmit the frequency with which it is being interrogated by the ship.

A weakening of the returned signal at a wavelength of 1.25 centimeters (K-band), for instance, would indicate the presence of water vapor. A strong attenuation at 5 millimeter wavelength would detect the presence of oxygen. The amount of weakening would reveal the content of oxygen in the planet's atmosphere. This beacon technique should be well developed by 1970.

FULL-SCALE MOCKUP of Fairchild M-185F jet transport is available for customer inspection at Hagerstown, Md. Long nose is designed to house radar. Passenger door is on left ahead of the wing. Main landing gear retracts into the side of the cabin.

Fairchild Sees Market for 600 M-185Fs

By Erwin J. Bulban

New York—A market of approximately 600 units exists for the new Fairchild M-185F four-jet eight-passenger business transport, according to Richard S. Boutelle, president of Fairchild Engine & Airplane Corp., Hagerstown, Md.

Boutelle said that this figure was developed during a market survey by the company aimed at finding out the sales potential for its new project. He expects that this potential will be reached within six years after delivery of the first M-185F.

Number one production M-185F will be delivered to Continental Can Co. sometime in 1960. The corporation has ordered three M-185Fs (AW Aug. 27, p. 33), in addition to a turboprop-powered Fairchild F-27 Friendship executive plane which it expects to receive in July 1958.

Continental Can Co., which became the first corporation to sign a letter of intent to purchase jet transports will get production airplanes numbers one, three and five. Fairchild will retain the experimental prototype for development and demonstration purposes. Continental will base the M-185Fs at its Morristown, N. J., operations and maintenance base. The company now has a fleet of five piston-engine executive planes: three Lockheed Lodestars, a Martin B-26 Marauder and a Convair LB-30 Liberator. It sets a target of 50 hr./month utilization per airplane and generally goes above that.

DISPLAY MODEL shows how wing leading edge is swept back about 25 deg., trailing edge about eight degrees. Extra fuel tanks will be hung between the engines and the wingtips.

Speed and Low Cost

Continental's quest for greater speeds to take advantage more effectively of executive productive capacity, estimated as worth thousands of dollars per hour, was indicated by company chairman Gen. Lucius D. Clay (ret.), who noted that the M-185F jets will be twice as fast as its current piston fleet. "Another important consideration is the cost factor . . . we estimate that the M-185F's operating cost will be about the same as one of our twin-engine Lodestars."

Addition of jet equipment will make the following schedules possible for company executives, according to Fairchild: New York to Chicago, 1 hr. 30 min.; New York to Miami, 2 hr. 20 min.; Chicago to Dallas, 1 hr. 40 min.; Dallas to Los Angeles, 2 hr. 40 min.; Los Angeles to Kansas City, 2 hr. 50 min.

Safety inherent in the four-engine layout was paramount in the thinking of Steve Brown, Continental chief pilot, who told AVIATION WEEK, the new jet will have a three-engine climb of 1,700 ft./min. to 3,000 ft./min. depending on loading. Ceiling of approximately 35,000 ft. can be maintained in event one of the turbojets flames out, he noted. Optimum operating altitude for the M-185F will be 45,000 ft., maintaining a cruise speed of about 470 kt. The M-185F is designed for a range of approximately 2,200 nautical miles at cruise setting taking into account a 70 mph. headwind and leaving 30 min. fuel reserve. Latter figures are based at sea level; at optimum altitude, the fuel reserve would come to about 45 min.

Continental's airplanes will be fitted with external auxiliary fuel tanks outboard of the engines giving a total of 1,800-1,900 gal.

Although a firm price was not disclosed for the executive M-185F, it is understood to be less than $1 million, minus certain equipment such as plug-in radio. A high Fairchild source estimated the company will break even on sales of less than 100 airplanes. It has spent approximately $2 million on development to date. An official estimates the program will cost about $6 million up to the first flight of the prototype. Fairchild is financing the venture privately, no military funds being used.

The company will borrow four Fairchild J83 jets with 50 hr. on them from USAF for prototype flying. These 2,-000-lb.-thrust-class engines are expected to be standard powerplant, although the General Electric J85, in approximately the same thrust class, may be substituted. Final powerplant decision will rest upon availability of engines in sufficient quantity and USAF's willingness to release them for civilian use. A Fairchild official noted that should J83s not be available in time for flight of the prototype, two Westinghouse J34s may be used to gain aerodynamic and flight data pending receipt of the specified engines. The prototype M-185F is expected to make its first flight late next year or early in 1958.

Performance Stretch

Considerable performance stretch is being built into the new Fairchild, an official estimates that within five years after the powerplants are certificated their thrust ratings will be 50% higher than current power. Pod mounting also makes it possible to consider engines of larger dimensions than current power plants. Previous M-185 configurations which had the engines mounted in the fuselage tail would have made this more difficult. Actually, the company went to underwing pods primarily because of customer resistance to buried powerplants. Continental expects that the M-185F's engines will be fitted with thrust reversers, and the landing roll performance is predicated on such an installation.

Detailed weight and performance data is not yet available, the company says, because of military security regarding the new J83 and J85 powerplants. The M-185F will span approximately 57 ft. and be about 56 ft. long.

Indications are that the plane will offer a brand new market to equipment makers, even with Fairchild studying ways and means of incorporating as much equipment as possible made by its various divisions, which specialize in air conditioning and pressurization.

Continental Chief Pilot Brown noted that his company has not yet made up a detailed specification of its equipment requirements in the airplane. "Most of the equipment will be new to us," he noted, "maybe some of it isn't even made yet." He pointed out that "you don't put piston-engine equipment in a jet airplane." For example, the company will obtain for its M-185Fs either the Sperry or Bendix autopilots similar to those going into the Boeing 707 and Douglas DC-8. It also plans to install Bendix C-Band weather radar.

Interior design and furnishings are other matters the corporation has not yet decided upon. Brown said that he expects to discuss these with Fairchild people soon.

All-Metal Polish Trainer Details Are Revealed

Vienna, Austria—First details to be disclosed on the new two-place Bies all-metal trainer, shown for the first time at the Poznan Fair, reveal that it has a 320 hp. engine and a top speed of 196 mph.

The Bies trainer closely resembles the North American T-28 in general configuration (AW July 9, p. 87). Gross weight is 3,410 lb. and range is about 435 mi. Rate of climb is reported to be 22.3 ft./sec. and ceiling as 19,685 ft.

The airplane is in quantity production. Equipment and other components are installed in sub-assemblies, which are later joined on a final assembly line.

Aeroflot Yak-12 Handles Light Utility Roles

Yak-12P, code-named Creek by NATO, is used by the Russians for a wide variety of utility duties including crop dusting, wolf hunting and ambulance missions. This airplane bears the insignia of Aeroflot, Russian national airline, typifying the carrier's diverse operations. Among the plane's features are closely spaced vane-like shutters enclosing the front of the 145 hp. engine, probably to maintain proper temperatures in Arctic operations, full-span leading edge wing slats and long-span trailing edge flaps to permit flying in and out of small, unprepared fields.

PRIVATE LINES

Cessna recently previewed 1957 Model 172 four-place business plane to dealers and distributors at Wichita, Kan. Full scale public showings of the new plane will be held on two successive weekends around the country on Sept. 29-30 and Oct. 6-7. Pattern of shows will follow successful promotion of Model 182 early this year (AW May 28, p. 100).

First civil deliveries of the new Bell 47J Ranger utility helicopter will begin early next year. Powered by a 260-hp. Lycoming VO-435-21 engine derated to 220 hp., the 47J will operate 600 hr. between major overhauls, company officials report. Useful load is 1,017.5 lb., gross weight 2,565 lb. At this gross weight the Ranger will climb from sea level to 5,000 ft. in 7.5 min. Fuel supply of 35 gal. will provide a 175-mi. range. Ranger received Type Certificate 2H-1 from Civil Aeronautics Administration recently. Its U. S. Navy counterpart is the HUL-1. Price announcement is expected at an early date.

U. S. exports of business aircraft of 6,000 lb. and less in the first half of 1956 totaled 443 units valued at $5,238,792, a 25% increase over the first half of last year. June 1956 exports totaled 69 airplanes valued at $933,309—a drop from June 1955, when 83 units valued at $1,005,920 shipped abroad.

De Havilland Dove is being used by personnel of Orenda Engines, Ltd., Toronto to visit RCAF bases to service the company's turbojet powerplants.

Winners of Aircraft Owners & Pilots Assn. nationwide membership contest: Donald G. Rhodes, Midvale, Utah, awarded a Champion Sky Trac and William J. Meehan, Elon College, N. C., received a Piper Tri-Pacer. The contest brought AOPA membership to a total of almost 58,000.

No. 1,000 Cessna 172 was delivered to Ward and Ralph McDowell, Ft. Worth, Tex., businessmen, eight months after the plane was introduced.

Three-day study course for airport management personnel is scheduled for Oct. 3-5 at the University of Oklahoma. Sponsors are The American Association of Airport Executives and the university in cooperation with CAA.

New distributor for Temco-Riley Twin Navion conversion is Van's Air Service, Wilmona, Minn., covering Minneapolis-St. Paul and neighboring area.

Stock Transactions

Disposal of 5,319 capital shares of Glenn L. Martin Company stock by George M. Bunker, officer and director of the company is reported by the Securities and Exchange Commission in its latest report. Mr. Bunker has a holding of 15,600 capital shares remaining.

Other transactions for the period May 11 to June 10 were:

Allegheny Airlines Inc. Acquisition of 1,000 common shares by Hugh R. Sharp, Jr., director, making a holding of 1,700.

American Airlines Inc. Disposal of 800 common shares by R. E. S. Delchler, officer, leaving a holding of 2,200.

American Electronics, Inc. Disposal of 400 common shares by Warren H. Caswell, director, leaving a direct holding of 4,050 and an indirect holding of 1,210.

Bendix Aircraft Corp. Acquisition of 370 common shares by Frank E. Hedrick, officer, making a holding of 3,688.

Bell Aircraft Corp. Acquisition of 200 common shares by Harvey Gaylord, officer, making a holding of 1,200; acquisition of 100 common shares by Walter A. Yates, director, making a holding of 4,250.

Beudix Aviation Corp. Acquisition of 175 common shares by N. F. Fenaline, officer, making a holding of 1,125; acquisition of 100 common shares by Henry A. Gossner, officer, making a holding of 300; acquisition of 700 common shares by William H. Houghton, officer and director, making a holding of 3,083.

Braniff Airways Inc. Disposal of 400 common shares by C. G. Adams, officer and director, leaving a holding of 10,753; acquisition of 300 common shares by Milton McGreevy, director, making a holding of 2,300.

California Eastern Aviation Inc. Disposal of 5,000 common shares by William W. Steinkeshoff, officer and director, leaving a holding of 82,989; disposal of 2,138 common shares by Edward A. Krebs, director, leaving a direct holding of 5,870 and an indirect holding of 765.

Capitol Airlines Inc. Disposal of 138 common shares by Hayes Dever, officer and director, leaving a holding of 3,500; disposal of 5,000 common shares by Charles H. Murchison, director, leaving a holding of 15,062; disposal of 250 common shares by Harold Gyrue Smith, director, leaving a holding of 1,028.

Cessna Aircraft Co. Acquisition of 200 common shares by Roy C. Russell, director, making a holding of 800.

Continental Aviation and Engineering Corp. Acquisition of 1,000 common shares by Carl F. Buchi, officer, making a holding of 1,250; acquisition of 1,000 common shares by James W. Kinnucan, officer, making a holding of 1,000.

Curtis-Wright Corp. Acquisition of 1,000 common shares through exercise of option by Sam D. Iwalt, officer, making a holding of 1,200; acquisition of 700 common shares through exercise of option by Joseph V. Missio, officer, making a holding of 2,800.

Emery Air Freight Corp. Acquisition of 100 common shares by Peter J. Byrne, officer, making a holding of 950; acquisition of 500 common shares by Walter G. Percoran, officer, making a holding of 1,214; acquisition of 1,000 common shares by John C. Emery, officer and director, making a holding of 11,000; acquisition of 500 common shares by John C. Emery, Jr., officer, making a holding of 1,604; acquisition of 200 common shares by A. M. McIver Campbell, officer, making a holding of 1,200; acquisition of 800 common shares by Henry A. Pfaff, officer, making a holding of 1,700.

Flying Tiger Line Inc. Disposal of $3,000 of 5½% convertible debentures by George T. Crosse, officer, his total holding disposal of $5,000 of 5½% convertible deben-

tures by Frank B Lycott, officer leaving a holding of 915,000

General Dynamics Corp Acquisition of 100 common shares by Sylvan C Coleman director making a holding of 100; disposal of 200 common shares by Robert P McKirdy, officer, leaving a holding of 0,010; disposal of 300 common shares by Reeve Schley, director leaving a holding of 4,043 shares

General Electric Co Acquisition of 500 common shares by Thomas R McCabe director making a holding of 2,500; disposal of 400 common shares by Gerald L Phillippe officer leaving a holding of 3,177; acquisition of 3,450 common shares by Charles K Rieger officer making a holding of 3,456 shares

General Motors Corp Disposal of 500 common shares by Richard C Gerstenberg officer leaving a holding of 5,765; disposal of 400 common shares by Gerald L Hogan officer leaving a holding of 23,507; disposal of 1,000 common shares by Cyrus R Osborn officer and director leaving a direct holding of 10,901 and an indirect holding of 322

Minneapolis-Honeywell Regulator Co Disposal of 500 common shares by C B Sweatt officer leaving a direct holding of 70,520 and an indirect holding of 9,230; disposal of 1,800 common shares by H W Sweatt officer and director leaving a direct holding of 85,660 and an indirect holding of 7,200; disposal of 1,200 common shares by John J Wilson officer and director leaving a holding of 1,800; acquisition of 100 common shares by P R Wishart officer and director making a holding of 4,370

National Airlines Inc Acquisition of 100 common shares by Edwin C McDonald director making a holding of 700

National Aviation Corp Acquisition of 210 common shares by Frederick F Robinson officer making a holding of 710; acquisition of 535 common shares by Marjorie E Tindall officer her total holding acquisition of 745 and disposal of 500 common shares by Elmer Wellin, director leaving a holding of 5,041

Pacific Northern Airlines Acquisition of 1,000 common shares by Dean E Hart officer making a holding of 3,000; acquisition of 500 common shares by Robert A Rowan director making a holding of 13,500

Philco Corp Disposal of 1,300 common shares by James S Buckley director leaving a holding of 3,551; disposal of 17,700 common shares by James H Carmine director leaving a holding of 15,138; disposal of 500 common shares by Raymond B George officer his total holding disposal of 900 common shares by Joseph H Gillies officer leaving a holding of 3,825; acquisition of 1,000 common shares by Russell L Rutledge officer making a holding of 1,515; acquisition of 1,000 common shares by John M Otter officer and director making a holding of 5,177; disposal of 500 common shares by R A Rich officer leaving a holding of 50; acquisition of 1,000 common shares by James M Skinner Jr officer making a holding of 9,676; acquisition of 200 common shares by William R Wilson officer making a holding of 15,200; disposal of 200 common shares by Leslie J Woods, officer and director, leaving a holding of 7,372

Trans Caribbean Airways Disposal of 2,175 class A common shares by O Roy Chalk officer and director leaving a holding of 21,234

Trans World Airlines Inc Acquisition of 52 and disposal of 150 common shares by John L Weller officer leaving a holding of 22

United Air Lines Inc Disposal of 100 common shares by R E Ahrens officer leaving a holding of 2,002; disposal of 300 common shares by R E Johnson officer leaving a holding of 2,700

United Aircraft Corp Acquisition of 147 common shares by Carroll L Gault officer making a holding of 1,827; disposal of 84 preference shares by Carroll L Gault, officer his total holding

Western Air Lines Inc Disposal of 200 capital shares by G G Brander officer leaving a holding of 1,800; acquisition of 200 capital shares by L Welch Pogue director, making a holding of 1,050

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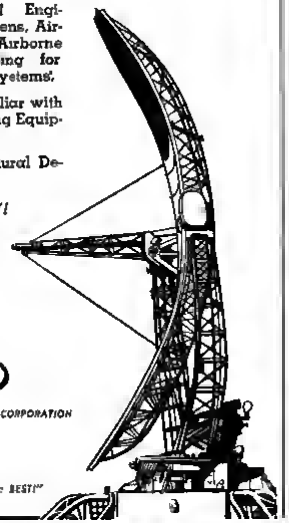

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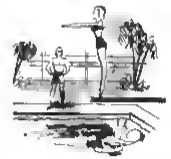

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After eight months of negotiation, Remmert-Werner has bought seven DC3 from DHY Turkish State Airlines, and has brought them to their conversion centers in St. Louis, Toledo, McBride, and Pompano Beach for complete overhaul and modification into private executive aircraft. A & E mechanics spent several months in Ankara disassembling, crating and moving the planes by cart, truck, and train (35 car loads) to Istanbul where they were shipped by freighter overseas to Mobile, then by barge up the Mississippi River. They had been unused by DHY since purchase from the USAF, and are the last of the low time DC3 C47s (from one to six thousand hours total).

Each will undergo two to three months of rebuilding, with installation of modern engines and electronic equipment, and will be delivered on a production schedule of one per month, with a new ship guarantee on the airframe, and an 800 hour guarantee on the engines. As they are staggered in various stages of construction, some may be completed with many custom specifications desired by their individual purchasers, including choice of Bendix or Collins executive radio and choice of engines—Super 92 Pratt & Whitney R1830 75, 92, 94, R2000, Wright R1820 56, -72, etc. Also available to order are such modern improvements as automatic pilot, X or C Band radar, extra Bendix, Collins, Sperry, A.R.C., Wilcox radio and electronics, Skydrol hydraulic fluid, lightweight landing gear doors, retractable or faired tail wheel, special cowlings, long range outer wing tanks, 26900 manual, additional picture windows, special interiors, etc.

The DC3 is a proven all-weather ship, "the world's most experienced airplane", and is still the most generally practical and efficient large executive aircraft available today, unsurpassed and unreplaced by later design. It has unquestioned dependability, with long range, high chock to chock speed, big capacity, big cabin, small airport ability, unequalled flexibility, top performance and handling characteristics, for economical maintenance and operating costs lower than those of many smaller planes. It makes the average business trip a matter of two or three comfortable hours of roomy, convenient, undisturbed privacy, with plenty of accommodations for extra passengers or baggage. Drop a line to Remmert-Werner today for an interesting history of this ubiquitous companion, with many fascinating anecdotes about its remarkable, many sided civilian, military, commercial and private careers.

Presently available are two executive DC3's which are available for immediate delivery with customer's choice of Collins or Bendix radio, and choice of engines. Both have been completely disassembled and overhauled, and carry a new ship guarantee on the airframe, and an 800 hour guarantee on the engines. One, N50F, is a deluxe DC3 which is today's fastest and quietest, with lightweight landing gear doors, retractable tail wheel, flush loops, and many other improvements. Further details may be had from Remmert-Werner, Inc., Lambert Field, St. Louis, Missouri.

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LETTERS

Thanks From ARDC

In behalf of all of us at the Air Research and Development Command I want to express to you and your staff our sincere appreciation and commendation for the outstanding job you have done on the recent ARDC edition of Aviation Week.

The result of your extraordinary effort exceeded my expectations. I am convinced that its benefits will be even greater and more far-reaching than I anticipated. Judging from the comments I have received so far, the impact of this edition will be felt widely and for a long time.

You are to be complimented for your foresight and your understanding of the exigencies of air research and development in compiling such an exhaustive report on all phases of ARDC's activities.

Please convey this expression of appreciation to the many members of Aviation Week's staff who, under your leadership, have worked so hard and for so long to make the ARDC edition a most professional, authoritative and valuable volume.

Thomas S. Power
Lieutenant General, USAF
Commander

Research Mission

The ARDC issue of Aviation Week was on my desk this morning when I returned from travel duty.

I want to congratulate you and your staff on the excellent documentation of the ARDC activities. The chapter on the Air Force Office of Scientific Research very clearly presents the mission of this organization and will be most helpful in publicizing our part in the overall Air Force research and development program.

H. F. Gregory
Brigadier General, USAF
Commander

From Industry: Bible

Your ARDC issue is a masterpiece. The vital information which you have assembled on all phases of ARDC activities is concise and yet written in sufficient detail to be of inestimable value to our company.

We have worked very closely with ARDC for the past 12 years on navigation aids, countermeasures, and coordinated on guided missile activities, but there is much in your comprehensive documentation which will serve as a Bible for our engineering activities and enable us to do a better job for the Pentagon in our research and development contracts with the various military agencies.

You and your staff deserve real credit for providing the aviation industry with a superb tool to increase our collective effectiveness in the research and development fields.

Please accept the gratitude of Gilfillan for assembling so much helpful information in such an authoritative and usable form.

Leonard David Callahan
Vice President
Gilfillan Bros. Inc.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Navy Sends Praise

Admiral Burke has asked me to write a note of thanks to you for the copy of Aviation Week's Air Research and Development Command edition which you so kindly left at his office.

This is an excellent portrayal of the fine work being done by ARDC. Like all of Aviation Week's special editions it serves as a fine reference book for all of us interested in aviation. As a long time subscriber to Aviation Week, I always keep the special editions available in my desk for ready reference, replacing them each year with the new edition.

Walter F. Cornnell
Lieutenant Colonel, U. S. Marine Corps
Aide to the
Chief of Naval Operations

Comprehensive Report

Sincere congratulations on the ARDC edition of Aviation Week, the most comprehensive and factual report ever published about the Air Force's research and development effort.

It has been a privilege to work with you on this far-reaching project, not only because of its great benefit to ARDC's mission but also because it was an enlightening experience to observe the dogged thoroughness and professional competence with which you and your staff tackled this tremendous job.

For a long time to come, Aviation Week's ARDC edition will serve as an invaluable guide and reference to our own personnel, to our contractors and to the many thousands who contribute directly or indirectly to the preservation of our aerial supremacy.

Outstanding in every respect, this volume is a credit to you, to the staff of Aviation Week and to the McGraw-Hill Publishing Co.

A. A. Arnhym
Colonel, USAF
Director of Information Services

The Arnold Story

The article by Bob Cushman in your Air Research and Development issue concerning the Arnold Engineering Development Center is perhaps the best ever written about this Center.

The novel approach, a chronological account of an industry customer's stay at the Center, was a very effective way to tell our story.

I am sure that this article will be of distinct service to many members of the aircraft and engine industry. It rehabilitates for them of the services and laboratory capabilities available to them here.

The story will help AEDC to carry out better its mission as a development center designed to serve industry and the armed services.

Although many of our engineers are subscribers to your magazine, I would like an opportunity to give a copy of this story to every employe at the Center.

Thus, we would appreciate your permission to reprint several thousand copies for our own use.

Jack Shea
Special Assistant to Managing Director
Aro, Inc.
Tullahoma, Tenn.

On President's Desk

The ARDC edition of Aviation Week is the best and most valuable issue I have thus far seen.

In fact, I had occasion to use it the first day it arrived. I shall keep it on my desk as a ready reference for all data concerning the Air Research and Development Command.

Therefore, please accept my congratulations for the success of your efforts in bringing to your subscribers such a wealth of valuable information.

You and your staff deserve the appreciation of the entire trade.

Orren L. Jones, President
Engineering Sales & Service Corp.
1518 K Street, Northwest,
Washington 5, D. C.

WADC Interest

The Air Research and Development Center Edition of Aviation Week, dated 6 August 1956, generated great interest in this laboratory.

The articles on ARDC and its various Centers were concise, extremely informative, and furnished considerable detailed data not otherwise available.

O. O. Snyder
Chief, Electrochemical & Corrosion Section
Protective Processes Branch
Materials Laboratory
Directorate of Research
Wright Air Development Center

Applauds 100% IFR

In reference to Captain Leo Krikoff's letter in the July 30 issue of Aviation Week (p. 102):

I salute you Captain for having the guts to call a spade a spade. I, too, am a little tired of dodging.

The answer to the present emergency is 100% IFR.

It may slow a few people down, but why should they hurry if they're going to die on the way?

William Penn Coleman, Jr.
Chief Aviation Pilot, USN
Operations Department
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Beeville, Texas


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